PROCEEDINGS *of the* HAWAIIAN ENTOMOLOGICAL SOCIETY *for* 1959

OTTO HERMAN SWEZEY
MEMORIAL NUMBER

VOL. XVII, No. 2
JULY, 1960

Suggestions for Manuscripts

Manuscripts should be typewritten on one side of standard-size white bond paper, double or triple spaced, with ample margins. The sheets should not be fastened together; they should be mailed flat. Pages should be numbered consecutively. Inserts should be typed on separate pages and placed in the manuscript in the proper sequence.

Footnotes should be numbered consecutively and inserted in the manuscript immediately below the citation, separated from the text by lines. They should be used only where necessary.

All names and references should be checked for accuracy, including diacritical marks. Authors' names must be spelled out when first mentioned.

Illustrations should be planned to fit the type page, 4½ x 7 inches. They should be drawn to allow for at least one-third reduction. Each should be labeled on the back with the author's name and title of the paper, as well as the number of the figure referred to in the text. Where size or magnification is important, some indication of scale should be given. They should be numbered consecutively, using capital letters to indicate parts of a composite figure. Printed letters are available from the Secretary. Legends should be typed on a separate sheet of paper and identified by the figure number.

Tables and graphs should be used only where necessary and omitted if essentially the same information is given in the paper. Graphs and figures should be drawn in India ink on white paper, tracing cloth, or light blue cross-hatched paper.

Proofs should be corrected as soon as received and returned to the editor with the abstract on forms provided. Additional costs to the Society for correction of authors' changes in proofs may be charged to authors. An order for reprints should be placed when proofs are returned.

Fifty gratis copies of reprints will be supplied by the Society to authors under certain circumstances. The Secretary should be consulted on this point.

Examination of articles in this issue will help in conforming to the style of presentation desired.

OTTO HERMAN SWEZEY
1869 - 1959

PROCEEDINGS
of the
Hawaiian Entomological Society

VOL. XVII, NO. 2 FOR THE YEAR 1959 JULY, 1960

JANUARY 12, 1959

The 637th meeting of the Hawaiian Entomological Society was held at the Experiment Station, HSPA, at 2:00 P. M. on Monday, January 12, 1959, with President Nishida presiding.

Members present: Balock, Beardsley, Bess, Bianchi, Burditt, Butler, Carter, Chilson, Chong, Clagg, Davis, Fullaway, Gressitt, Hardy, Hinckley, Holloway, Joyce, Kajiwara, Kamasaki, Keck, Kim, Kimoto, Krauss, Look, Maehler, S. Mitchell, W. Mitchell, P. Nakagawa, Nakata, Nishida, Ota, Pemberton, D. Rainwater, Sherman, Suehiro, Steiner, Thistle, Wilton, Woolford, Worthington, and Yamada.

The Society voted to present an award for the best entomological exhibit at the Second Annual Hawaiian Science Fair which is to be held during March. Dr. Pemberton was appointed to serve as chairman of a committee to select an appropriate award. The sum of 100 dollars was voted for the Zoological Society of London as the Hawaiian Entomological Society's contribution toward the publication of the ZOOLOGICAL RECORD. It has been the policy of the Society to send fifty dollars for this purpose to the Zoological Society of London each year, and the present contribution will be for the years 1958 and 1959.

The president extended the Society's best wishes for a successful future to Mr. Maehler who will be moving to California in the near future.

Mr. Krauss gave an interesting account of his work and travels through Southeast Asia during the past year while searching for enemies of the giant African snail, lantana, and other weed pests for the State Board of Agriculture and Forestry.

NOTES AND EXHIBITIONS

Aedeomyia catastica Knab **on Guam:** Miss Nakata reported for Dr. W. W. Cantelo, entomologist for the U. S. Navy on Guam, that two males and one female of this mosquito were first collected in a light trap near Apra Harbor, Guam, on January 22, 1958, and that the species has since been taken frequently

in light traps in the Apra Harbor area. This is the first record of *A. catastica* on Guam, and it appears that the species became established there sometime after 1955, when a light trap was last operated at Apra Harbor. This mosquito is widespread in the Oriental Region and may have been introduced into Guam from the Philippine Islands or the Western Carolines (see R. M. Bohart, 1956. INSECTS OF MICRONESIA 12(1):20–21).

Coptotermes formosanus Shiraki: Messrs. Clagg and Keck exhibited two pieces of commercially pressure-treated lumber which had been entered and damaged by this termite. The treated lumber was placed against the concrete wall of a gate valve box in an area near the Honolulu International Airport known to be infested with subterranean termites. In November, 1958, after the wood had been in the valve box for nearly a year, it was found that a termite colony had entered the box and built tubes up the walls to the wooden cover, and also had entered the pieces of treated wood.

Bishop Museum entomological field work: Dr. Gressitt reported that field work on the Bishop Museum's "Zoogeography and Evolution of Pacific Insects" project had added about one million specimens to the Museum's collections during 1958. The largest accessions were the result of Mr. Maa's work in Thailand, Malaya, Sarawak, and North Borneo; Dr. Milliron's in the Philippines; Mr. Brandt's and Dr. Gressitt's in New Guinea; Dr. Quate's in North Borneo and Malaya; and the gift of Dr. Kellen's Samoan collection. Other accessions included Mr. Malkin's from New Hebrides, New Caledonia, and Fiji; Dr. Joyce's from New Caledonia; Mr. Krauss' from Japan, Okinawa, Taiwan, Hong Kong, Philippines, Malaya, Ceylon, and Guam; Dr. Snyder's from the Bonin Islands; Dr. Laird's from the Tokelau Islands; and gifts from Malaya, Singapore, and elsewhere. Material collected in New Guinea by Drs. Marks and Smart is being processed by them, and duplicates will be sent to the Museum.

FEBRUARY 9, 1959

The 638th meeting of the Hawaiian Entomological Society was held at the Experiment Station, HSPA, at 2:00 P.M. on Monday, February 9th, 1959, with President Nishida presiding.

Members present: Balock, Beardsley, Bess, Bianchi, Burditt, Butler, Chilson, Chong, Clagg, Davis, Ford, Fullaway, Gressitt, Hardy, Joyce, Kajiwara, Kamasaki, Kim, Kimoto, Look, Lukins, S. Mitchell, W. Mitchell, Miyake, Nakata, Nishida, Pemberton, Quate, D. Rainwater, I Rainwater, Sherman, Steiner, Sugerman, Tanaka, Woolford, Worthington, and Yoshimoto.

Visitors: Mr. Russell D. Anderson, Mr. Bernard Pang Ching, and Dr. Wolfgang Quednau.

Dr. Gressitt gave a brief report on the Colloquium of Zoological Nomenclature and the Fifteenth International Congress of Zoology which he attended in London, during July of 1958.

Dr.Quednau discussed his recent research work at the Riverside campus of the University of California where he investigated the use of radio isotopes in studying the inter-relationships of aphids, their parasites, and their host plants.

Dr. Gressitt presented an excellent kodachrome-illustrated talk on his recent collecting trip to New Guinea, and his visits to various research organizations in countries of the Southwest Pacific area.

Notes and Exhibitions

Suncus murinus (L.) **on Guam:** Miss Nakata reported for Dr. Cantelo that this shrew is becoming increasingly abundant on Guam. Traps in some areas have caught four times as many shrews as rats. The shrew has been observed to feed on living specimens of the giant African snail.

Drosophila bizonata Kikkawa and Peng: Dr. Hardy reported that six specimens of this fly had been sent to him for identification from the State Department of Agriculture and Conservation. The flies had been reared from mushrooms from Japan which were intercepted by Mr. Look's office. This is the first record of *D. bizonata* in Hawaii. The species is not known to be established here, although people have reported finding mushrooms infested with maggots in local markets. The fly is common throughout Japan and is considered a serious pest of mushrooms. The identification has been confirmed by Dr. T. Okada of Tokyo Metropolitan University, the leading authority on Japanese drosophilids.

A stylopized fruit fly: Dr. Hardy reported that he had recently received a specimen of *Dacus* (*Neodacus*) *curvifer* Walker from the Sepik District in the Territory of Papua and New Guinea which contained a male puparium and three female Strepsiptera. Dr. Hardy stated that he knew of no previous records of Diptera serving as hosts of Strepsiptera.

Macrosiphum ibarae Matsumura: Dr. Hardy stated that he had been informed by Mr. V. F. Eastop of the British Museum (Natural History) in London that this name (Jour. Coll. Agric. Sapporo 7(6):397, 1917) is the correct one for the aphid which has been known in our literature as *M. rosae* (L.). Mr. Eastop also wrote that our *Macrosiphum granarium* (Kirby) belongs to the subspecies *miscanthi* Takahashi.

Macrosiphum pisi (Harris): Mr. Look reported for Mr. Stephen Au that this aphid was collected on alfalfa plants at Waimea, Kauai, on January 7, 1959. This is the first record of the pea aphid from Kauai. The determination was made by Miss Louise M. Russell of the Division of Insect Identification in Washington, D.C.

Pseudonapomyza spicata (Malloch): The secretary reported for Mr. Au that this agromyzid leaf-miner had been reared from corn leaves collected at Poipu, Kauai, and that specimens were identified by Dr. Hardy. This is a new island record of the species. Numerous eulophid parasites were reared from the leaf-miner infested corn leaves and these appeared to be responsible for considerable mortality among the flies.

Terastia meticulosalis Guenée: Mr. Beardsley exhibited a specimen of this pyralid moth which was taken in an HSPA light trap at Waipio, Oahu, in December, 1956. This capture seems worthy of record as Zimmerman (INSECTS OF HAWAII 8:44–45, 1958) stated that there was reason to doubt that this species was established here. The only previous Hawaiian record of *T. meticulosalis* was that of Mr. Swezey ("PROCEEDINGS" 5(2):297–298, 1923)[1] who reared moths from caterpillars found feeding in the seed pods of *Erythrina*.

Hypophloeus (Paraphloeus) maehleri Kulzer: Mr. Ford reported that this tenebrionid beetle, first reported in Hawaii in 1953 as *Hypophloeus* sp. ("PROCEEDINGS" 15(2):284, 1954), was described by Kulzer in INSECTS OF MICRONESIA (vol. 17(3):233, 1956). In addition to Hawaii, the species is known from the Mariana and Caroline Islands. The specimens were determined by Mr. Ford.

Blapstinus histricus Casey: This tenebrionid beetle, first found in Hawaii by Mr. Ford in 1953, and reported as *Blapstinus* sp. ("PROCEEDINGS" 15(2):284, 1954), has been identified as *B. histricus* by T. J. Spilman and Hans Kulzer. It is also known from southern California.

Xyletobius gossypii Ford: Mr. Ford reported that a specimen of this endemic anobiid beetle was collected in a light trap at Camp Halena, Molokai, January 2, 1959, by H. A. Woolford. This is a new island record as the species previously was known only from Oahu.

Onthophagus catta (Fabricius):[2] Mr. Ford exhibited several specimens of this scarabaeid dung beetle which had been collected in a black light trap operated by the USDA Plant Quarantine Division at Wahiawa, Oahu, during December, 1958. This species appears to be one which was introduced purposely by the State Department of Agriculture and Conservation from Southern Rhodesia and liberated in March, 1957. This is the first record indicating the establishment of the beetle in Hawaii.

Scaphytopius loricatus (Van Duzee): Mr. Ford reported finding numerous adults of this cicadellid leafhopper on *Sida fallax* Walpers (*ilima*) at Barber's Point, Oahu, during January, 1959. This is the first Hawaiian host record for the leafhopper which was discovered here by Dr. Joyce in 1953 ("PROCEEDINGS" 15(2):287, 1954).

Prognathogryllus sp.: A male specimen belonging to this endemic genus of crickets was collected by Mr. Ford near Puu Hapapa, Waianae Mts., Oahu, in January, 1959, and appears to represent an undescribed species. The two described species known from Oahu are mottled light and dark brown, while this specimen is mostly black with lemon yellow forewings.

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[1] Throughout this publication "PROCEEDINGS" refers to PROCEEDINGS OF THE HAWAIIAN ENTOMOLOGICAL SOCIETY.

[2] Specimens submitted by the Office of the State Entomologist were determined as this species by Dr. O. L. Cartwright of the U. S. National Museum during March, 1960. The species is widely distributed in Africa and India.

MARCH 9, 1959

The 639th meeting of the Hawaiian Entomological Society was held at the Experiment Station, HSPA, at 2:00 P.M. on Monday, March 9, 1959, with President Nishida in the chair.

Members present: Anderson, Beardsley, Bess, Bianchi, Burditt, Butler, Chock, Chong, Davis, Ford, Fullaway, Gressitt, Hardy, Holloway, Joyce, Kamasaki, Kim, Kimoto, Look, S. Mitchell, W. Mitchell, Nakata, Nishida, Pemberton, Sherman, Suehiro, Thistle, Worthington, Woolford, and Yoshimoto.

Visitors: Mrs. E. J. Ford, Jr., and Mr. John Mann.

Mr. Russell D. Anderson, Mr. Sidney H. Blunt, and Mr. Bernard Pang Ching were elected to membership in the Society.

Dr. Hardy extended an invitation to members of the Society to attend a seminar on the subject of population dynamics which will be conducted by Dr. L. C. Birch of the University of Sydney. The seminar will be held on the University of Hawaii campus on Monday, March 30th.

Mr. John Mann, entomologist for the Lands Department, Queensland, Australia, gave a most interesting account of his travels in South America where he had searched for insect enemies which might be utilized to combat the weed pest *Heressia* sp. in Australia.

Dr. Joyce, who recently returned from two months in New Caledonia, gave an informative and well illustrated talk on the arthropods of medical importance which he studied on that island.

NOTES AND EXHIBITIONS

Glossiphonia weberi Blanchard: Mr. Davis exhibited several live specimens of this leech which had been collected by Mr. Thistle in Hauula, Oahu. Under laboratory conditions, this leech was observed to attack the fresh water snails *Lymnaea ollula* Gould, *Physa compacta* Pease, and *Pseudosuccinia columella* (Say). The species is common in streams of Oahu, has been found on Kauai, and probably occurs on other islands of the Hawaiian group. Specimens were determined by Professor Marvin C. Meyer at the University of Maine. The earliest published record of leeches in the Hawaiian Islands is that of W. A. Bryan (NATURAL HISTORY OF HAWAII, p.440, 1915), and the known Hawaiian forms were treated in detail by Percy J. Moore in 1946 (OCCASIONAL PAPERS OF THE BERNICE P. BISHOP MUSEUM 18(11):171–191).

Epitrix hirtipennis (Melsheimer): Dr. Sherman reported that the tobacco flea beetle, known previously in our literature as *E. parvula* Fabricius, should now be known as *E. hirtipennis*. Dr. George Vogt of the U. S. National Museum examined specimens sent by Dr. Sherman and found them to be *E. hirtipennis*. Dr. Vogt indicated that the true *E. parvula* of Fabricius apparently does not occur in Hawaii or the continental United States.

Gasteracantha cancriformis (L.): Dr. Hardy reported that this spiny-backed spider which was first found in the Makiki area of Honolulu in April, 1954 ("PROCEEDINGS" 15(3):378, 1955) has since spread in all directions from the site of the original discovery, and has been collected recently from localities as far away as Wahiawa and Kaneohe, Oahu.

Haptoncus luteolus (Erichson): Mr. Ford exhibited four specimens of this nitidulid beetle which he had collected at Barber's Point, Oahu, in October and November, 1949. The specimens were mixed with a series of *H. mundus* Sharp, which it closely resembles. *H. luteolus* has not previously been reported in Hawaii, but additional specimens may be found mixed with *H. mundus* in other local collections. *H. luteolus* is of nearly cosmopolitan distribution in the tropics and subtropics, and is known to occur in Guam as well as Texas and Central America. Mr. Ford compared Hawaiian specimens with specimens from Fiji determined as *H. luteolus* by E. A. Chapin of the U. S. National Museum. A detailed description of *H. luteolus* is given by H. E. Hinton, MONOGRAPH OF THE BEETLES ASSOCIATED WITH STORED PRODUCTS, Vol. 1, p. 104, 1945.

Spodoptera mauritia acronyctoides (Guenée): Mr. Bianchi reported that on February 28, 1959, he had collected numerous moths, caterpillars, and egg masses of this armyworm at Wainaku, Hilo, Hawaii. The eggs and moths were on buildings in and near the HSPA substation, and the caterpillars were feeding on sugar cane seedlings planted in flats laid out in the yard of the substation. This is the first record of the lawn armyworm on the big island.

Achatina fulica Bowdich: Mr. Chock reported the discovery of an infestation of the giant African snail on the island of Hawaii. He stated that Mr. John Kamekona of 432 Desha Ave., Keaukaha, Hawaii had found specimens of the African snail in his yard on February 24th, and had brought them to Mr. Harry Nakao, Department of Agriculture and Conservation entomologist on Hawaii. A check of the area revealed that the infestation involved approximately 8.5 acres of the Hawaiian Homes Commission property. The density of the snail population was light and, judging from the size of those recovered, the infestation was approximately two years old. An initial aircraft broadcasting of metaldehyde pellets was completed on March 5th, and further action on the problem will depend upon the results obtained from this application. Although the African snail has been intercepted on the island of Hawaii previously, this is believed to be the first report of its establishment there.

Hedylepta blackburni (Butler): Mr. Kim reported that caterpillars of this pyralid moth were severely damaging the leaves of coconut trees along the windward coast of Oahu in the vicinity of Chinaman's Hat (Mokolii Island).

Graphomya maculata (Scopoli): Dr. Joyce reported identifying a number of specimens of this muscid fly in Board of Health light trap catches from the McKay Radio Station near Kailua and the Keolu Hills of Oahu. This fly has not been reported since it was first discovered in Hawaii in 1948 ("PROCEEDINGS" 13(3):329, 1949).

Chrysopa basalis Walker: Dr. Gressitt reported that the name *Chrysopa microphya* McLachlan has been synonymized with *C. basalis* by P. A. Adams in INSECTS OF MICRONESIA 8(2):24, 1959. This green lacewing is widely distributed in the Pacific and has been known here under the former name for many years.

APRIL 13, 1959

The 640th meeting of the Hawaiian Entomological Society was held at the Experiment Station, HSPA, at 2:00 P.M. on Monday, April 13, 1959, with President Nishida in the chair.

Members present: Anderson, Balock, Beardsley, Bess, Burditt, Butler, Carter, Chong, Clagg, Davis, Fullaway, Gressitt, Hardy, Holloway, Joyce, Kajiwara, Kamasaki, Kim, Kimoto, Look, W. Mitchell, Nakata, Nishida, Ota, Pemberton, Quate, D. Rainwater, Suehiro, Sugerman, Thistle, Wilton, Woolford, Worthington, and Yoshimoto.

Dr. Pemberton, Chairman of the Entomology Award Committee and a member of the judging panel for the Second Annual Hawaiian Science Fair, reported that our Society's award for the best entomological exhibit at the Science Fair was presented to Miss Iris Yamaoka, a student at Farrington High School who participated in the Senior Division of the fair. Miss Yamaoka presented an excellent and informative exhibit entitled "Biological Control of the Oriental Fruit Fly". The exhibit illustrated in detail, with proper labels and living material, both the Oriental fruit fly and certain of its parasites, with particular emphasis on *Opius oophilus* Fullaway. She was awarded a well documented and illustrated book entitled THE WORLD OF SCIENCE.

Dr. Bess gave a brief report on the program of the Inter-Society Science Education Council, on which he serves as this Society's representative.

Mr. Thistle discussed the need for sending information on insect infestations in Hawaii for inclusion in the USDA COOPERATIVE ECONOMIC INSECT REPORT which is issued weekly by the Plant Pest Control Division of the Agricultural Research Service. The members present voted to instruct the Secretary to send a copy of the "Notes and Exhibitions" section of the minutes of our Society's monthly meetings to the above agency for this purpose.

The Secretary read a letter from the Director of the Zoological Society of London expressing his thanks for our annual contribution toward the publication of the ZOOLOGICAL RECORD.

Dr. Quate presented an excellent kodachrome-illustrated account of his recent travels through Malaya and North Borneo, where he collected insect specimens for the Bishop Museum.

NOTES AND EXHIBITIONS

Cyrtorhinus lividipennis Reuter: For Mr. Harry Nakao of Hilo, Mr. Davis reported that this mirid bug had been found established at Mukai's Farm,

Kapoho, Hawaii, during February. This insect, which feeds on the eggs of the corn leafhopper, *Peregrinus maidis* Kirkaldy, was introduced into the state from Guam by Fullaway in 1939, and was first liberated on Hawaii at Kapoho in February, 1954.

Melanagromyza splendida Frick: Dr. Hardy reported that this agromyzid fly has been causing serious damage to celery plantings in Kaimuki, Oahu. *M. splendida* has been previously recorded from celery, lettuce, squash, and sweet potatoes on the islands of Oahu and Hawaii.

Orthezia insignis Browne: Dr. Hardy reported the occurrence of a very heavy infestation of the greenhouse orthezia on *Lippia* in the Punahou area of Honolulu. The bugs were observed migrating from the infested *Lippia* onto a patio where they created a considerable nuisance.

Macrosiphum pisi (Harris): Dr. Hardy reported that specimens of the pea aphid from alfalfa recently were sent to Professor Essig at the University of California, and that he has confirmed the identity of this species in Hawaii.

Melittobia hawaiiensis Perkins: Mr. Beardsley called attention to a paper by G. R. Gradwell entitled "The selection of a Neotype for *Melittobia hawaiensis* Perkins and the Re-erection of the Genus *Aceratoneuromyia* Girault (Hymenoptera-Eulophidae)" in the ENTOMOLOGISTS MONTHLY MAGAZINE, Fourth Series 19:277–278, 1958. This little wasp is a parasite of certain Lepidoptera and Hymenoptera in Hawaii.

Scaphytopius loricatus (Van Duzee): Mr. Beardsley reported that he had found both nymphs and adults of this immigrant cicadellid leafhopper plentiful on the foliage of *Pluchea odorata* (L.) Cass., at Barber's Point, Oahu, April 10, 1959. This is a new Hawaiian host record for the leafhopper.

Protaetia fusca (Herbst): Dr. Gressitt stated that this beetle had been reported doing considerable damage to maize in a garden near Wailuku, Maui. According to the verbal report which he received, the beetles were not only feeding on the tassels, but were crawling into the ears and feeding on the kernels.

A new journal on Pacific entomology: Dr. Gressitt reported that the Bishop Museum is establishing a new journal, PACIFIC INSECTS, primarily to handle monographs on insects of the Southwest Pacific. The journal will publish principally systematic papers, but may also include some on ecology and zoogeography. Dr. Gressitt is editor, and members of the editorial committee include D. E. Hardy, M. A. Lieftinck, T. C. Maa, I. M. Mackerras, L. W. Quate, J. J. H. Szent-Ivany, R. L. Usinger, and K. Yasumatsu. The journal will be published quarterly at Fukuoka, Japan, where Dr. Yasumatsu will supervise publication. Dr. C. M. Yoshimoto of the Bishop Museum is business manager. The subscription price is five dollars per year.

MAY 11, 1959

The 641st meeting of the Hawaiian Entomological Society was held at the

Experiment Station, HSPA, at 2:00 P.M. on Monday, May 11, 1959, with President-elect Joyce presiding.

Members present: Anderson, Balock, Beardsley, Burditt, Butler, Chong, Chock, Davis, Fullaway, Hardy, Joyce, Kajiwara, Kamasaki, Kim, Look, Lukins, W. Mitchell, Nakata, Pemberton, Quate, Suehiro, Tanaka and Thistle.

Dr. Joyce gave a brief report on the recent meeting of the Executive Committee of the Hawaiian Academy of Sciences. He also reported that the Inter-Society Science Education Council of the Academy will continue to function and suggested that an alternate delegate be designated to represent the Hawaiian Entomological Society at ISSEC meetings when our official representative is unable to attend.

Dr. Butler presented a very interesting and well illustrated talk on his recent trip to Laysan Island.

Notes and Exhibitions

Dictya abnormis Steyskal: Mr. Davis exhibited several adult specimens of this sciomyzid fly which recently has been introduced into Hawaii to help combat the liver fluke snail, *Lymnaea ollula* Gould. Two shipments of *D. abnormis*, which is native of Mexico, were received in April from Dr. Clifford Berg of Cornell University. The flies are being reared in the Board of Agriculture and Forestry insectary, and field releases are planned for the near future.

Phrynosoma cornutum (Harlan): Mr. Kim exhibited a specimen of this horned-toad lizard which he had collected on 17th Avenue near the Diamond Head Cemetery in the Kaimuki section of Honolulu, on April 8th, 1959.

Hypoderma bovis (L.): Dr. Hardy exhibited two adult specimens of this warble fly which were collected by Mr. Noah Pekelo on the island of Molokai. These apparently are the first adult warble fly specimens to be collected in Hawaii, although numerous larvae have been collected and determined as *H. bovis*.

Cryptophlebia illepida (Butler): Dr. Hardy stated that he has received numerous reports of damage to the fruit of litchi, *Litchi chinensis* Sonn., by larvae of this olethreutid moth. The scarabaeid beetle *Protaetia fusca* (Herbst) has been observed feeding on the juices which exude from holes made in fruit by *C. illepida* larvae.

Hypena jussalis Walker: Mr. Chock reported that this noctuid moth, an introduced enemy of lantana, is now well established on all major islands of the state. Dr. Butler, Mr. Chock, and Mr. Miyahara observed heavy populations of this insect in the Ulupalakua section of Maui on May 7, 1959, and Mr. Chock studied a large area of lantana around Keokea, involving six or eight square miles, over which most of the lantana bushes were completely defoliated. In

addition to *H. jussalis* larvae, a few adults of the lantana tingid bug, *Teleonemia scrupulosa* Stål, were present on the few remaining leaves. When this area was visited previously in March, *H. jussalis* damage was light and the lantana was then growing luxuriantly.

JUNE 8, 1959

The 642nd meeting of the Hawaiian Entomological Society was held at the Experiment Station, HSPA, at 2:00 P.M. on Monday, June 8, 1959, with President Nishida in the chair.

Members present: Balock, Beardsley, Bess, Bianchi, Burditt, Butler, Chilson, Chock, Chong, Clagg, Davis, Fullaway, Hardy, Hinckley, Holloway, Kamasaki, Keck, Kim, Kimoto, Nakata, Ota, Pemberton, Quate, D. Rainwater, Sherman, Suehiro, Sugerman, Thistle and Yoshimoto.

The Secretary read a copy of the congratulatory telegram which was sent in the name of the Society to Dr. Otto H. Swezey on the occasion of his 90th birthday.

A letter from Mr. Sidney Blunt of Birmingham, England, was read to the members present. Mr. Blunt, a member of our Society, graciously offered to collect English moths and butterflies for exchange with anyone interested.

NOTES AND EXHIBITIONS

Cactoblastis cactorum (Berg): Mr. Davis reported for Mr. Stephen Au of Kauai that during May of this year larvae of this pyralid moth were found infesting a rope cactus, *Selenicereus* sp., at the home of Mr. Sandy Moir. This is a new Hawaiian host record for *C. cactorum*.

Anacamptodes fragilaria (Grossbeck): Through Mr. Davis, Mr. Au also reported the presence of large populations of *A. fragilaria* in an area of west Kauai extending from Mahaulepu to Mana. In some parts of this region the caterpillars of this geometrid moth had completely defoliated *Leucaena glauca* (L.) Benth. bushes, and were also observed feeding on foliage of *Epidendron*, citrus, litchi, mint, pear (*Pyrus*), and on the fruit of the white-flowered gourd. Apiarists have also reported severe damage to algaroba (*Prosopis*) trees, and were concerned about the possible effect such damage might have upon honey production. Dr. Pemberton noted that this species has recently been reported attacking citrus in California, and that orange is included in the long list of Hawaiian host records given by Zimmerman (INSECTS OF HAWAII 7:38, 1958).

Gonaxis kibweziensis (Smith) and **G. quadrilateralis** (Preston): Mr. Davis exhibited eggs of the giant African snail, *Achatina fulica* Bowdich, which had been partially eaten by these two carnivorous snails under laboratory conditions. Similar predation of African snail eggs by these species has been observed frequently in the field.

Hedylepta blackburni (Butler): Mr. Davis also reported that the coconut leafroller, *H. blackburni*, which caused much destruction to coconut fronds between Kualoa and Kahuku, Oahu, in March of this year, recently has severely defoliated palms along the coastal strips of Waimanalo, Kailua, and Lanikai. The peak of larval activity apparently occurred between May 17th and May 24th, and numerous adults were observed between June 1st and June 8th.

Pseudococcus maritimus (Ehrhorn): Mr. Beardsley reported that he had recently identified specimens of this mealybug for Dr. George Butler which had been collected during May near Olinda, Maui, on gorse. This is a new island record for the grape mealybug which previously has been known here only from Oahu.

Nysius delectus White: Mr. Beardsley reported that on June 7th Mr. Ford and he had found this native lygaeid bug extremely abundant on flowers and foliage of *Metrosideros collina polymorpha* (Gaud.) Rock and *Coprosma* sp. along the Waianae summit ridge in the vicinity of Palikea Peak, Oahu. The bugs were present by the thousands on the foliage of these plants in a limited area of the summit ridge about one-half mile long.

New insect records from Molokai: Mr. Chilson reported the following new Molokai records based on specimens collected by Mr. Woolford during a collecting trip in the latter part of December, 1958. Determinations were made by specialists at the U. S. National Museum.

Kalotermes immigrans Snyder (Isoptera). Camp Halena, light trap.

Deltocephalus sonorus Ball (Homoptera; Cicadellidae). Camp Halena, light trap.

Chalybion bengalense (Dahlberg) (Hymenoptera; Sphecidae). Kaunakakai, flying.

Entomobrya atrocincta Schott (Collembola). Halena Gulch, modified Berlese funnel.

Entomobrya multifasciata (Tullberg) (Collembola). Halena Gulch, modified Berlese funnel.

Entomobrya atrocincta has not been reported previously in Hawaii, but is a widespread form which is known from the continental United States, Europe, Australia, and New Zealand. It has been redescribed and illustrated by E. A. Maynard, A MONOGRAPH OF THE COLLEMBOLA OR SPRINGTAIL INSECTS OF NEW YORK STATE, Comstock Publishing Co., Ithaca, New York, pp.145–149, 1951.

New Hawaiian Scaptomyza: Dr. Hardy reported that the following thirteen new Hawaiian species of drosophilid flies of the genus *Scaptomyza* Hardy have recently been described by Dr. W. Hackman of Finland (ACTA ZOOLOGICA FENNICA 97:3–73, 1959).

Scaptomyza (*Trogloscaptomyza*) *mediopallens* Hackman, from Kaula Gulch, Hawaii.

S. (*T.*) *mitchelli* Hackman, from Paliku, Haleakala Crater, Maui.

S. (*T.*) *aloha* Hackman, from Puu Alii, Molokai.
S. (*T.*) *striatifrons* Hackman, from Waialae Stream, Kauai.
S. (*T.*) *abrupta* Hackman, from Haleakala Crater, Maui.
S. (*T.*) *longipecten* Hackman, from Puu Kolekole, Molokai and Lanaihale, Lanai.
S. (*T.*) *pallifrons* Hackman, from Kaula Gulch, Hawaii and Haleakala, Maui.
S. (*T.*) *hawaiiensis* Hackman, from Kaula Gulch, Hawaii and Haleakala, Maui.
S. (*T.*) *hardyi* Hackman, from Waialae Stream, Kauai.
S. (*T.*) *kauaiensis* Hackman, from Kawaikoi Stream, Kauai.
S. (*Parascaptomyza*) *longisetosa* Hackman, from Manawainui Valley, Molokai and Puu Kukui, Maui.
S. (*Bunostoma*) *cordigera* Hackman, from Oahu.
S. (*B.*) *bryanti* Hackman, from Kula Pipe Line, Maui.

The type of *S.* (*Bunostoma*) *cordigera* is being deposited in the U. S. National Museum, while types of the other new species are to be deposited in the Bernice P. Bishop Museum.

Rhabdoscelus obscurus (Boisduval): Mr. Bianchi stated that on May 16th, in a young ratoon field of sugar cane at Grove Farm, Kauai, he found a number of shoots about a foot high harboring young larvae of the sugar cane weevil borer. At a subsequent visit a month later, all the shoots had been killed and the borer larvae had disappeared, probably having starved in the absence of enough nutrient material to complete their development. This destruction of young shoots by *R. obscurus* larvae is probably not unprecedented, but has not been previously recorded in the cane fields of Hawaii.

July 13, 1959

The 643rd meeting of the Hawaiian Entomological Society was held at the Experiment Station, HSPA, at 2:00 P.M. on Monday, July 13, 1959, with President-elect Joyce in the chair.

Members present: Balock, Beardsley, Bess, Bianchi, Bryan, Butler, Carter, Chong, Hardy, Hinckley, Holloway, Joyce, Kim, Kimoto, Look, Lukins, W. Mitchell, Nakata, Ota, Pemberton, Quate, D. Rainwater, Sakimura, Sherman, Suehiro, Sugerman, Woolford and Yoshimoto.

Visitors: Mr. Charles E. Bracker, Jr., Dr. Dale H. Habeck, Dr. Albert R. Mead, Dr. Eleanor H. Slifer, Dr. Wilson S. Stone, Dr. Marvin Wasserman, and Dr. Marshall R. Wheeler.

Dr. Hardy read a letter from the Committee on Common Names of Insects of the Entomological Society of America which asked for clarification on two proposed common names submitted to them by the Hawaiian Entomological Society. The members present voted to propose the names "cosmopolitan army-

worm" for *Pseudaletia unipuncta* (Haworth) and "lawn armyworm" for *Spodoptera mauritia acronyctoides* (Guenée), the two species to which the letter referred.

Dr. Bess reported that he had appointed Mr. Minoru Tamashiro as the Society's alternate representative on the Inter-Society Science Education Council.

The Secretary read a letter from the Hawaiian Botanical Society which requested our support in opposing the establishment of Axis deer and other game mammals on the island of Maui. The membership voted to instruct the Secretary to write a letter to the Board of Commissioners of Agriculture and Forestry in support of the stand taken by the Hawaiian Botanical Society.

Dr. Pemberton informed the Society of the death of Dr. E. A. Back, on May 22, 1959. Dr. Back, a member of this Society from November 1912 through December 1915, came to Hawaii in 1912 as entomologist for the U. S. Bureau of Entomology and Plant Quarantine to initiate federal investigations on the Mediterranean fruit fly and to set up federal quarantines designed to prevent the introduction of that insect into the continental United States.

Dr. Eleanor Slifer of the University of Iowa delivered an interesting and informative report of her studies on the chemoreceptors of Acrididae. Drs. Walter Carter and Martin Sherman each gave a brief report on the recent meetings of the Pacific Slope Branch of the Entomological Society of America which were held in Sacramento, California.

Notes and Exhibitions

Hedylepta blackburni (Butler): Mr. Bianchi reported that the coconut leaf-roller has been responsible for much defoliation of coconut palms in the vicinity of Lahaina, Maui, during the past few months.

Spodoptera mauritia acronyctoides (Guenée): Mr. Bianchi reported also that he had recently collected adult specimens of the lawn armyworm at Lahaina. The previous record of this moth on Maui was based on larvae reared from egg masses collected at Waihee ("Proceedings" 17(1):20, 1959).

Iridomyrmex humilis (Mayr): Mr. Beardsley reported finding the Argentine ant established along the Manoa Cliff Trail on Mt. Tantalus, Oahu, on June 20, 1959. The ants were evident for about one-half mile along the trail, and were observed tending mealybugs, principally *Pseudococcus montanus* Ehrhorn on *Freycinetia* vines. Mr. Beardsley commented further that during the past several years this ant has considerably extended its range in sugar cane fields both at Ewa and Waialua, Oahu.

August 10, 1959

The 644th meeting of the Hawaiian Entomological Society was held at the Experiment Station, HSPA, at 2:00 P.M. on Monday, August 10, 1959, with President-elect Joyce in the chair.

Members present: Adachi, Beardsley, Bess, Bianchi, Butler, Chock, Chong, Clagg, Davis, Fullaway, Gressitt, Habeck, Hardy, Holloway, Joyce, Kamasaki,

Kim, Kimoto, Look, W. Mitchell, Nakata, Namba, Ota, Pemberton, D. Rainwater, Sherman, Steiner, Sugerman, Tamashiro, Thistle, Toba, Woolford and Yoshimoto.

Visitors: Dr. Hubert Caspers, Lt. (j.g.) Edsel M. Fussell, USN, Mr. Alvin Tanabe, and Mrs. Ercell Woolford.

Dr. Dale H. Habeck was elected to membership in the Society.

Dr. Hubert Caspers of the University of Hamburg, Hamburg, Germany, who is doing research in Hawaii on the biology of marine midges of the family Chironomidae, gave a very well illustrated and informative talk on the tidal and lunar periodicity of *Clunio murinus* Haliday. Dr. Caspers also discussed some of the problems he has encountered in studying the Hawaiian species of *Clunio*.

Notes and Exhibitions

Hedylepta blackburni (Butler): Dr. Bess reported that the coconut leafroller had done considerable damage to coconut foliage in exposed coastal areas on the east end of Molokai, but that not much damage was evident in and around Kaunakakai.

Eutochia lateralis (Boheman): Mr. Bianchi reported that larvae of this tenebrionid beetle had been found boring into sugar cane seedpieces, particularly into the "eyes" thereof, in cane planted for experimental purposes near Pahoa, Hawaii. About a third of the seedpieces had been ruined by the beetle larvae in an acre plot in a small kipuka (area isolated by lava flows) of good soil surrounded by lava from the Kilauea eruption of 1955. This species has been reported doing serious damage to cane only once before, in 1922 at Kohala, Hawaii.

Homoneura striatifrons (de Meijere): Dr. Hardy exhibited a single male specimen of this lauxaniid fly which he had recently found misplaced among some unidentified drosophilids. The specimen was collected in January, 1908, at Nahiku, Maui; no collector given. *H. striatifrons* previously was known only from the type specimen from Tjibodas, Java (Tijdschrift voor Ent. 67:52, 1924), and apparently has never been collected in Hawaii since 1908.

Macrosiphum pisi (Harris): Dr. Hardy reported this aphid as very abundant in alfalfa fields on Molokai, but apparently not doing much damage. This is a new island record for the pea aphid. Dr. Hardy further noted that U. S. workers apparently still are using *Macrosiphum* rather than the newer name *Acyrthosiphon* for the genus of the pea aphid.

Vesiculaphis caricis (Fullaway): Mr. Fullaway reported that recently he had secured additional information on the distribution of this aphid which he described from a specimen collected in Pauoa Valley, Oahu, on *Carex*, in 1909. A specimen of this species was recently collected on *Azalea* in a nursery at Altaville, Calaveras County, California and sent to Miss Louise Russell of the Division of Insect Identification in Washington, D. C. Miss Russell has written that there are specimens of the species in the Division's aphid collection from

Azalea from Washington, D. C., 1927; South Carolina, 1932; New Jersey, 1949; Maryland, 1952; and Connecticut, 1958. Miss Russell also pointed out that this species has been reported from Formosa and Japan

SEPTEMBER 14, 1959

The 645th meeting of the Hawaiian Entomological Society was held at the Experiment Station, HSPA, at 2:00 P.M. on Monday, September 14, 1959, with President-elect Joyce in the chair.

Members present: Balock, Beardsley, Chilson, Chong, Clagg, Davis, Fullaway, Gressitt, Hardy, Holloway, Ito, Joyce, Kamasaki, Look, Lukins, S. Mitchell, Nakata, Ota, D. Rainwater, Suehiro, Sherman, Sugerman, Tamashiro, Tanabe, Wilton, Woolford.

Visitors: Dr. Hubert Caspers, Mr. Gary Masuoka, Mr. Fernando F. Sanchez, and Mr. Chojiro Tomizawa.

Lt. (j.g.) Edsel M. Fussell, USN, and Mr. Alvin Tanabe were elected to membership in the Society.

Dr. Gressitt stated that during the recent visit of Dr. R. L. Usinger, tentative plans were made for the entomology program for the Tenth Pacific Science Congress, which is to be held in Honolulu during the late summer of 1961. A tentative program for the congress, outlining symposia topics, convenors, and invitational speakers will be drawn up within the next few weeks.

Dr. Gressitt gave an interesting account, well illustrated with color slides, of his recent trip to Kyushu University, Japan, and his subsequent collecting trips to Netherlands New Guinea, Admiralty Islands, and British Solomon Islands.

NOTES AND EXHIBITIONS

Gasteracantha cancriformis (L.): Mr. Clagg reported the presence of this showy spider from the Naval Air Station at Barber's Point, and from the Naval Ammunition Depot at Waikele, Oahu.

Iridomyrmex humilis (Mayr): Mr. Ito reported that he had recently found the Argentine ant established in upper Palolo Valley.

Mr. Davis presented the following notes for Mr. Chock:

Apanteles ruficrus Haliday: The State Department of Agriculture and Conservation recently received two shipments of *Apanteles* cocoons from the Philippine Islands, collected by Mr. E. Capco, entomologist for the Bureau of Plant Industry of the Philippines. In addition to the *Apanteles*, a pteromalid hyperparasite, identified by Dr. B. D. Burks of the U. S. National Museum as *Trichomalopsis apanteloctonus* Crawford, also emerged from his material. The *Apanteles* is being propagated in the Board of Agriculture and Forestry insectary, and initial releases were made at Kailua and Diamond Head, Oahu, during August. *A. ruficrus* is a gregarious parasite of various noctuid larvae, including *Spodoptera mauritia acronyctoides* (Guenée). Cocoons of this species will be found in clusters rather than

singly as are those of *A. marginiventris* (Cresson). *A. ruficrus* was previously introduced from Fiji in 1951, but apparently did not become established.

Sepedon macropus Walker: Mr. Stephen Au, Board of Agriculture and Forestry entomologist on Kauai, recovered three specimens of this sciomyzid fly, which was introduced recently to combat the liver fluke snail, at Yoshitake's taro field in Waimea Valley, on September 4, 1959. *S. macropus* was released at this locality on April 29, 1959. The fly has a recorded longevity of six months under laboratory conditions, but the recovered flies are believed to be progeny of the initial release. Dr. George Butler recovered two females of *S. macropus* in West Kauai during June, 1959.

Caulophilus sp., probably **latinasus** (Say): Mr. Beardsley reported that he had recently received this determination from Miss Rose E. Warner of the U. S. National Museum for specimens of a small weevil which he had found in light trap catches from Waipio, Oahu, during August, 1959. This is a new insect record for the state. *C. latinasus* (see BIOLOGIA CENTRALI-AMERICANA 4(7):40, 1909–1910) is known from California and the southeastern U. S., as well as Mexico, Central America, Puerto Rico, Venezuela, and Madeira. Miss Warner writes that it is a seed pest and has been reported infesting avocado seeds, stored chicken peas, and Indian corn (Barrett, R. E., PAN-PACIFIC ENT. 7(4):191, 1931). Specimens in the U. S. National Museum from Mexico were collected on orchids.

Onthophagus catta (Fabricius): Mr. Beardsley exhibited specimens of this scarabaeid dung beetle which has been plentiful in HSPA light trap catches at Waipio, Oahu, during the past two months. Specimens of this beetle were previously taken by Mr. Ford in a light trap at Wahiawa, Oahu.

Plusia (Lophoplusia) violacea Swezey: Mr. Beardsley exhibited noctuid moth specimens belonging to the rarely collected endemic subgenus *Lophoplusia* Zimmerman (see INSECTS OF HAWAII 7:359–365, 1958) which had been collected at light by Mr. Ford and himself in native forest areas on Oahu and Kauai. *P. violacea* was described from a single female from Kokee, Kauai, and no additional specimens had been reported until now. Three males were secured during August in a light trap operated by Mr. Beardsley at Kokee, and during July a pair of specimens which seem very close to *P. violacea* were captured at light by Mr. Ford on a ridge near Puu Kanehoa, Waianae Mts., Oahu.

OCTOBER 12, 1959

The 646th meeting of the Hawaiian Entomological Society was held at the Experiment Station, HSPA, at 2:00 P.M. on Monday, October 12, 1959, with Secretary Mitchell presiding.

Members present: Anderson, Balock, Beardsley, Bess, Burditt, Chilson, Chock, Chong, Carter, Davis, Ford, Fullaway, Gressitt, Habeck, Hardy, Hinckley, Holloway, Ito, Kamasaki, Kim, Look, Lukins, Maehler, McMahan, S. Mitchell, W. Mitchell, Nakata, Ota, Pemberton, D. Rainwater, I. Rainwater, Rosa, Sanchez,

Tamashiro, Tanabe, Thistle, Toba, Wilton, Woolford and Worthington.

Visitors: Mr. Kazuhiko Ando, Dr. Ernest N. Cory, Mrs. D. T. Fullaway, Mr. Robin Leech, Dr. Earle G. Linsley, Mr. Isabelo P. Pascual, and Mr. David M. Thompson.

Mr. Fernando F. Sanchez was elected to membership in the Society.

Mr. Robin Leech gave a very interesting and excellently illustrated account of his trip across Africa as a member of the California Academy of Science expedition in 1958.

Notes and Exhibitions

Acheta sp.: Dr. Hardy reported that numerous complaints had been received by his office during the past several weeks concerning large numbers of crickets entering houses at Ewa, Oahu, and doing considerable damage by chewing holes in clothing.

Anoplolepis longipes (Jerdon): Mr. Ito reported that he had found this ant established in the vicinity of Roosevelt High School in the Makiki section of Honolulu. This immigrant species has been reported previously from the Pearl Harbor area of Oahu, and from Kona, Hawaii.

Tasconotus sp.: Mr. Ford reported that several specimens of this little colydiid beetle were taken during 1959 in light traps operated by Mr. Beardsley, Dr. Joyce, and himself respectively at Waipio, Honolulu, and Hickam Air Force Base, Oahu. Mr. Ford identified the specimens by comparing them with specimens from Guam collected by K. L. Maehler and determined by R. H. Arnett in Washington, D. C. This is a new insect record for the state.

Saprinus sp.: Four specimens of a species belonging to this genus of histerid beetles were collected at light in Wahiawa, Oahu, by Mr. Ford, during June and July, 1959. The species appears to be new to the Hawaiian fauna.

Acinopterus angulatus (Lawson): A specimen of this cicadellid leafhopper, which was reported here for the first time during 1958 ("Proceedings" 17(1):20, 1959), was collected at Hickam Air Force Base, Oahu, in a black light trap during August, 1959, by Mr. Ford. Additional specimens also have been taken by Dr. Joyce in a light trap at Fort Armstrong, Honolulu. These captures indicate that the species is definitely established here.

Carphuroides pectinatus (Sharp): Mr. Ford stated that this malachiid beetle has been known previously in our literature as *Helcogaster pectinatus* Sharp in the family Malacodermidae. There are but three specimens of this species in local collections (1 from Honolulu, October, 1920, D. T. Fullaway collector; 1 from South Kona, Hawaii, August, 1924, W. Giffard collector; and 1 from Hickam Air Force Base, Oahu, March, 1959, at light, E. J. Ford collector). However, Perkins (Fauna Hawaiiensis 3(5):368, 1908) stated that the species occurred in Honolulu, and was occasionally numerous in houses. The species was assigned to *Carphuroides* by Champion (Ann. and Mag. Nat. Hist. ser. 9, 12:46, 1923).

Graptostethus manillensis (Stål): Dr. Pemberton reported that during September, 1959, large numbers of adults and nymphs of this lygaeid bug were observed on a vine of the hairy morning glory, *Merremia aegyptia* (L.) Urban, which was growing on a fence on the southern slope of Diamond Head, Honolulu. The bugs were mostly concentrated on the well-developed to mature seed capsules. Adults were observed piercing the capsules with their stylets and feeding on the contained immature seeds. From four to six adults commonly were seen feeding on a single capsule. Newly hatched nymphs were found feeding within capsules which had matured sufficiently to crack open slightly. Examination of many mature capsules disclosed a large proportion of the contained seeds were collapsed and decaying. No eggs were found in or on the capsules or elsewhere on the plants, though the presence of many nymphs in all stages of development clearly indicated that the bug was actually breeding on this plant.

This insect was first collected in Hawaii by Mr. K. Sakimura in a windtrap at Kunia, Oahu, July 21, 1942, as reported by Swezey ("PROCEEDINGS" 11(3): 284–285, 1943). From time to time thereafter entomologists in Hawaii have reported finding *G. manillensis* on various plants; but in only one case previously have nymphs been observed together with adults on any plant. Swezey ("PROCEEDINGS" 12(2):335–340, 1945) reported finding adults and nymphs on the wood rose, *Ipomoea tuberosa* L. Zimmerman (INSECTS OF HAWAII (3):51, 1948) reported observing adults feeding on the ovaries of the Kuhio vine, *Ipomoea horsfalliae* Hook., but did not mention seeing nymphs on this vine. Barber (INSECTS OF MICRONESIA: LYGAEIDAE 7(4):180, 1958) records *Ipomoea cairica* (L.) Sweet as a host plant of this bug and lists its distribution as Sumatra, Java, Philippine Islands, Australia, Hawaiian Islands, Southern Marianas and the western Caroline Islands. There are no local records of *I. cairica* as a host in Hawaii, though this will probably be demonstrated after further study.

Sepedon macropus Walker: Mr. Davis reported that this sciomyzid fly was found to be established at Waiahole, on the windward coast of Oahu, during September. Larvae of this fly prey on aquatic snails, and the species was purposely introduced into Hawaii to combat the liver fluke snail, *Lymnea ollula* Gould. Egg rafts, larvae, and adults were observed in a taro patch at Waiahole, and adult flies were trapped by placing crushed liver fluke snails as an attractant in an invaginated McPhail-type glass trap. This is the first recovery of *S. macropus* on Oahu since the original releases were made in December, 1958. Releases were made at Waiahole during January and July of 1959. The recovery of *S. macropus* on Kauai was reported in September, and the possibility of establishing this species on all the major islands appears very promising.

Lantana camara L. var. **aculeata** Moldenke: Mr. Davis reported that according to Mr. Noel Krauss the wild lantana of the Hawaiian Islands has been identified as this variety by Dr. Harold N. Moldenke, authority on lantana.

Bishop Museum Antarctic research: Dr. Gressitt reported that the Bishop Museum has received a grant from the National Science Foundation for partic-

ipation in the U. S. Antarctic Research Program ("Deep Freeze '60"). The principal undertaking of the Bishop Museum project will be the study of natural dispersal, and insect trapping will be carried on aboard ships, aircraft, and on the Antarctic continent. The field work will be done by Mr. Leech and Mr. C. W. O'Brien, a graduate student at the University of California, as well as by Dr. Gressitt. Dr. Gressitt exhibited several nets designed for trapping work in the Antarctic, and stated that types designed for use aboard small aircraft have already been tested on light planes over Oahu by Mr. Leech and himself.

November 2, 1959

The 647th meeting of the Hawaiian Entomological Society was held in Gartley Hall, University of Hawaii campus, at 2:00 P.M. on Monday, November 2, 1959, with President-elect Joyce in the chair.

Members present: Anderson, Beardsley, Bess, Burditt, Carter, Chong, Clagg, Einmo, Fullaway, Gressitt, Habeck, Haramoto, Hardy, Hinckley, Kamasaki, Joyce, Look, Lukins, McMahan, S. Mitchell, W. Mitchell, Nakata, Ota, Owen, Pemberton, Sanchez, Steiner, Suehiro, Tamashiro, Tanabe, Tanaka, Thistle, Toba, Wilton and Woolford.

Visitors: Mr. Jay E. Graham, Dr. Stanley B. Freeborn, Mr. Isabelo P. Pascual, and Dr. F. J. Simmonds.

Messrs. John Einmo, Robin Leech and David M. Thompson were elected to membership in the Society.

Dr. F. J. Simmonds of the Commonwealth Institute of Biological Control delivered a thought-provoking address entitled "Some Aspects of Biological Control at the Present Time".

Notes and Exhibitions

Zelus renardii Kolenati: Mr. Fullaway exhibited specimens of this reduviid bug which Mr. Davis had captured on croton shrubs at Kailua, Oahu. Mr. Davis observed these bugs capturing and feeding on adult muscid Diptera.

December 14, 1959

The 648th meeting of the Hawaiian Entomological Society was held at the Experiment Station, HSPA, at 2:00 P.M. on Monday, December 14, 1959, with President-elect Joyce presiding.

Members present: Anderson, Beardsley, Bess, Bryan, Burditt, Chock, Chong, Clagg, Davis, Einmo, Ford, Fullaway, Fussell, Habeck, Hardy, Kamasaki, Kim, Joyce, McMahan, S. Mitchell, W. Mitchell, Nakata, Pascual, Pemberton, D. Rainwater, Sanchez, Steiner, Suehiro, Tamashiro, Tanabe, Thistle, Thompson, Toba and Woolford.

Visitor: Mr. Kazuhiko Ando.

The following officers were elected for the year 1960:

President	C. R. Joyce
President-elect	J. W. Beardsley
Secretary	W. C. Mitchell
Treasurer	Amy Suehiro
Advisors	Walter Carter
	D. Elmo Hardy

The membership was saddened by the news that Dr. Otto H. Swezey, a charter member of the Hawaiian Entomological Society and for many years Editor of these "PROCEEDINGS", died in San Jose, California, on November 3, 1959. Dr. Pemberton read a biographical sketch of Dr. Swezey which he has prepared for publication in our "PROCEEDINGS". Dr. Swezey had been an honorary member of this Society since August, 1945.

The Secretary received word that another honorary member of the Society, Sir Guy A. K. Marshall of the British Museum (Natural History) in London, passed away on April 8, 1959. Sir Guy Marshall was elected to honorary membership in the Hawaiian Entomological Society in June, 1942. A biographical sketch of this distinguished coleopterist has been published in the ANNALS AND MAGAZINE OF NATURAL HISTORY, 13th Series, vol. 1(12):573–574, December, 1959.

Mr. Steiner gave a few remarks concerning the Unit Citation Award for Superior Service given to the USDA Fruit Insects Investigation Laboratory in Honolulu by Secretary of Agriculture Benson.

NOTES AND EXHIBITIONS

Grassiella sp.: Dr. Hardy reported that specimens of a species belonging to this genus of lepismatid Thysanura were recently collected in association with the crazy ant, *Paratrechina longicornis* (Latreille), in Honolulu. These specimens resemble closely those discussed and figured by Zimmerman (INS. HAWAII 2:38, fig. 6, 1948) who treated the material which he studied as an unidentified genus and species. Dr. Hardy's specimens were sent to Dr. P. Wygodzinsky, Buenos Aires, Argentina, who reported that they belong in the genus *Grassiella* Silvestri of the lepismatid subfamily Nicoletiinae. Dr. Wygodzinsky wrote further that both the specimens sent were females, which are extremely difficult to identify to species. He stated that the genus *Grassiella* is known from the Neotropical and Ethiopian regions, but may prove to occur in the Oriental and Australian Regions as well. Our species is probably introduced, he believes, and the population here may prove to be parthenogenetic.

Recent numbers of Insects of Micronesia: Miss Nakata reported that the following numbers of the INSECTS OF MICRONESIA series have been published during 1959: Vol. 8, no. 2, Anoplura, by G. F. Ferris, and Neuroptera–Myrmeleontidae and Chrysopidae, by Phillip A. Adams; Vol. 12, no. 3, Diptera–Cera-

topogonidae, by Masaaki Tokunaga and E. K. Murachi; Vol. 12, no. 4, Diptera–Psychodidae, by Larry W. Quate; and Vol. 14, no. 3, Diptera–Neriidae and Micropezidae, by Martin L. Aczél. Other entomological papers published by the Bishop Museum during 1959 include: OCCASIONAL PAPERS OF THE BISHOP MUSEUM Vol. 22, no. 7; Curculionid Genus *Gymnopholus* (Coleoptera), by Sir Guy A. K. Marshall; and Vol. 22, no. 9, Acarina from Southeastern Polynesia–II (Oribatidae), by Max Sellnick.

Sepedon macropus Walker: Mr. Chock reported that this predaceous marsh fly was found established at Waimalu, in the Aiea district of Oahu. Egg rafts, larvae and adults of the fly were collected or observed in and around taro patches in this area on December 10, 1959. *S. macropus* was previously found established at Waiahole on the windward side of the island.

Oxythira maya Denning: Mr. Beardsley reported the capture of specimens of this introduced caddisfly in a light trap at Kokee, Kauai, during August of this year. This is a new island record for the species which has been recorded previously only from Oahu and Hawaii.

Atrichopogon jacobsoni (de Meijere): Dr. Joyce reported that this ceratopogonid fly has been collected in a light trap at Fort Armstrong, Honolulu, on several occasions during 1959, and has apparently become well established here. The species was first discovered by Dr. Joyce at Fort Armstrong in August, 1958 ("PROCEEDINGS" 17(1):28, 1959). During November, 1959, a single male specimen was taken in a light trap at the Honolulu International Airport, a considerable extension of its known range here.

Culicoides varipennis (Coquillett): A single specimen of this biting gnat, (PROC. U. S. NAT. MUS. 23:602, 1901), was taken in a light trap at the Honolulu International Airport on November 12, 1959. *C. varipennis* is common over much of the continental United States, and has a reputation for being a vicious biter. No species of *Culicoides* has previously been reported from the Hawaiian Islands, and it is hoped that this species does not become established here, as some *Culicoides* are known to transmit filarial worms and are suspected as vectors of blue tongue disease of livestock. Identification of the specimen was confirmed for Dr. Joyce by Dr. W. W. Wirth of the U. S. National Museum.

Otto Herman Swezey

1869-1959

On November 3, 1959, Dr. Otto Herman Swezey died of pneumonia at the age of 90, after two and one-half weeks hospitalization in a sanitarium near San Jose, California, where he was confined following several falls at home which caused serious injury to his back; thus ending the long career of one of Hawaii's most distinguished and deeply respected scientists. He and Mrs. Swezey were charter members of the Hawaiian Entomological Society. Forty-eight of his active years were spent in Hawaii and his achievements in the service of the sugar planters and to the community as a whole have been outstanding.

Dr. Swezey was born June 7, 1869, on a backwoods farm six miles east of Rockford, Illinois. He comes of ancestors who came to Salem, Massachusetts, from England in 1632, many of whom have since become prominent in the fields of music and medicine. A few years ago Mrs. Swezey induced him to write his autobiography. He began this but never finished it. However, from a few pages in his clear handwriting, we learn that his early school days were spent in what was then the Guilford Center School House, described by him as a one room, wooden structure located in the center of Guilford Township, which was a six square mile area devoid of church, store, railroad station, post office or even a saloon. When he was about 16 or 18 years of age his teacher, who was a university graduate, influenced him to enter a university. Entrance without an examination or tuition fee was open to him providing he had a teacher's certificate. He acquired a teacher's certificate by passing an examination and then began his collegiate training in entomology at Lake Forest College, Illinois, where he received his Bachelor of Arts degree in 1896. In 1897 he was granted a Master of Arts degree at Northwestern University, Illinois, where he had a Fellowship during 1896–1898. He served at this university as biology instructor during 1898–1902. He then secured a Fellowship at Ohio State University as a research student in entomology, where he studied during 1902–1903. He was also employed through 1903 and part of 1904 as Assistant Nursery and Orchard Inspector for the Ohio State Department of Agriculture.

From his brief autobiographical notes we find that at the age of 6 or 8 he first became interested in insects through reading a small book entitled "Insect Lives Or Born In Prison". Amongst insects illustrated in this book was a picture of the beautiful Cecropia Moth, *Samia cecropia* L., and its cocoon. He had previously seen this cocoon on an apple tree in the garden. In the winter he brought such a cocoon into the house and hung it up in the kitchen. Later, one evening in March, a fine *Cecropia* adult emerged from the cocoon and was seen flying about in the house. This was the start of a life-time interest in rearing

Lepidoptera from whatever caterpillars he found. Then in a similar manner he reared out the adults of the showy butterflies *Papilio turnus* L. and *Papilio asterias* Cramer. He stated that his first experience in economic entomology began in efforts to reduce damage to potato foliage in the garden by the Colorado Potato Beetle *Leptinotarsa decemlineata* (Say). He shook the larvae into a pan held below and killed them with hot water or kerosene and later sprinkled the infested rows with paris green suspended in a bucket of water.

By 1904, Dr. Swezey had published several important papers on certain economic leafhoppers and their parasites in Ohio. It was at this time that the sugar-cane leafhopper, *Perkinsiella saccharicida* Kirkaldy, was devastating sugar-cane in Hawaii. His published work was brought to the attention of the Hawaiian Sugar Planters' Association through Dr. L. O. Howard, then Chief of the U. S. Bureau of Entomology. This resulted in his employment as Assistant Entomologist at the HSPA Experiment Station about June, 1904. He promptly married Mary H. Walsh on July 20, 1904 and they came to Honolulu on August 12th. He immediately launched into the work of receiving, breeding and distributing parasites of the sugar-cane leafhopper, then being shipped to Hawaii from Australia, where they were discovered by Albert Koebele and R. C. L. Perkins. It is of record that Dr. Swezey became the first American entomologist to be employed in private industry.

In 1915, Dr. Swezey was promoted to the position of Entomologist at the HSPA Experiment Station, which post he held until retirement in 1933, when he became Consulting Entomologist. Following retirement he continued to work actively, especially with the Hawaiian Lepidoptera, until his final departure for the mainland to reside at San Jose, California.

As Honorary Curator on the staff of the Bernice P. Bishop Museum for the years 1906–1919, Dr. Swezey gave generously of his spare time in organizing, preserving and adding to the extensive insect collections of that institution. In those days, with a very limited staff, the Museum sorely needed and appreciated the service he rendered. In 1920 the Museum appointed him Consulting Entomologist, and in 1953 he was named Honorary Consultant, which title he held until 1959. He was the actual founder of the entomology section of the Museum.

In 1944, the University of Hawaii granted him an Honorary Degree of Doctor of Science, an honor of which few are more deserving. He was a member of the American Association for the Advancement of Science, The American Association of Economic Entomologists, The Entomological Society of America, The Hawaiian Entomological Society, The Hawaiian Botanical Society, The Hawaiian Academy of Science, The Pan Pacific Club, The Trail and Mountain Club and the Outrigger Canoe Club. He was President of the Hawaiian Entomological Society four times and Editor of its Proceedings for 39 years. As Editor he performed an extraordinary service in the careful editing of the first eleven volumes, comprising a total of 5,087 pages of biological and other technical

matter. This exacting and trying work was a duty he cheerfully assumed. He set a standard of excellence and precision that has served as a model for the ensuing editors.

During 1936, Dr. and Mrs. Swezey spent seven months on the island of Guam conducting an entomological survey of the island. They were assisted part of the time by Dr. Robert L. Usinger and Mr. E. H. Bryan, Jr., who were associated with the Bernice P. Bishop Museum. This project was under the auspices of the Hawaiian Sugar Planters' Association. A thorough survey was made of the whole island, which resulted in the collection of many hundreds of insects, with essential notations with reference to host plants, etc. These were later segregated into natural groups and sent to various world specialists for study. Part of the aggregate included material collected by D. T. Fullaway in 1911. Resulting from this work, some 39 separate papers were published in two volumes by the Bernice P. Bishop Museum under the title INSECTS OF GUAM. These two volumes comprise a total of 455 pages of descriptive matter and form a major reference work on the insects of that island. It is to Dr. and Mrs. Swezey's credit that this was accomplished. Dr. Swezey made two trips to Samoa; the first in 1923 for four weeks and the second in 1940 for 13 weeks. Much useful information was obtained and recorded on the insect pests of the region and material additions were made to the general insect collections of the Bishop Museum.

The voluminous entomological publications by Dr. Swezey emphasize his intense interest in, and thorough knowledge of, the insect world in general. He left hundreds of records covering his observations on the habits and identity of Hawaiian insects. Over 300 publications have appeared under his name. They stand as a fitting monument to him and with the passage of time their reference value will gain, rather than lose, in usefulness. A great number of his contributions have appeared in the PROCEEDINGS OF THE HAWAIIAN ENTOMOLOGICAL SOCIETY. Apart from special papers by him, the first fourteen volumes are filled with short notes and comments on observations made by him from day to day on habits or identity of insects seen by him on the streets of Honolulu, at his home, in the cane fields or in the mountains which he frequently visited. He has described 107 species of Lepidoptera, and other entomologists have named 78 insects after him.

In addition to his intensive studies of the sugar-cane insects of Hawaii, his greatest contributions to entomology deal with the endemic, native and immigrant Lepidoptera of Hawaii. In Dr. E. C. Zimmerman's INSECTS OF HAWAII, Volume 7, which covers the Macrolepidoptera of the Islands, a moving tribute is paid to Dr. Swezey and his work with the Hawaiian Lepidoptera. In his preface Zimmerman states in part that "Much of what I have recorded herein regarding the habits and early stages of the Hawaiian Lepidoptera has come from the researches of Dr. Swezey. This book would be a mere shadow of itself if it were not for the observations made by him over a period of nearly 50 years. No other person, or combination of persons, has contributed so much to our knowledge

of the biologies of the Lepidoptera of Hawaii". Again, on page 28 of the same volume, he states, in part, that "Dr. Swezey was absolutely devoted to his studies, and he assembled an enormous mass of records on the biologies of Hawaiian insects. We are indebted to him for the bulk of our knowledge on the habits, hostplants, parasites and early stages of the Hawaiian Lepidoptera. He belonged to that school of men who seek after knowledge for its own sake".

Shortly after Dr. Swezey came to Hawaii he became interested in the endemic insect fauna of the Hawaiian forests. At every opportunity during forty of his most active years, he roamed the mountain forests where he collected and studied the habits and host relations of these insects. In the course of such investigations he became one of the leading Hawaiian authorities on the endemic flora of the Islands. During this long period he assembled an impressive mass of carefully recorded notes, which covered in detail the hostplants, locality, and often the parasites of all insects collected in the forests. The immature stages of these insects were also studied and recorded in his notes and the adults were added to reference collections. He had long planned to place on record in published form the results of this work. During his later years his colleagues urged him to do so and he began the laborious task of preparing the manuscript. As a crowning culmination and climax to his long career as an entomologist, he finally put the finishing touches to his manuscript on October 15, 1952, a few hours before his steamer bore him and his good wife permanently from Hawaii. This manuscript was published August 2, 1954, by the Bernice P. Bishop Museum, in collaboration with the Hawaiian Entomological Society and the Hawaiian Botanical Society, under the title FOREST ENTOMOLOGY IN HAWAII, and appeared as SPECIAL PUBLICATION 44. It is an annotated check-list of the insect faunas of the various components of the Hawaiian forests. Its 266 pages are packed with concise and reliable information, highly informative to foresters, botanists and entomologists.

Dr. Swezey was greatly revered by all of his colleagues and friends. He was tolerant of all conditions and people that confronted him and was prone to overlook or excuse the faults or mistakes of others, rather than criticize. And finally though he was rich in achievements and honors in his chosen field of science, he always remained a modest and unassuming man.

He is survived by his wife and one son, Joseph A. Swezey, and two grandchildren.

C. E. Pemberton

Publications by Dr. Otto H. Swezey

Compiled by
C. E. PEMBERTON

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Two Unusual Delphacid Leafhoppers from Kauai (Homoptera)

JOHN W. BEARDSLEY
EXPERIMENT STATION, HSPA
HONOLULU, HAWAII

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The two species of endemic Hawaiian leafhoppers reported upon here were part of a collection of miscellaneous insects made while searching for endemic mealybugs in the native forest areas of Kauai during August of 1959. This field work was made possible through a grant of funds from the McInerny Foundation of Honolulu, and I wish to express my sincere appreciation to the foundation for their support of this research. The figures of the species described below as new were drawn by Mrs. Dorothy Rainwater of the Bishop P. Bishop Museum, to whom I am indebted for her talented assistance. The genitalia drawings were done by me.

Nesothoë magnacornis, new species (figs. 1, A-C; 2, A-B).

Male. Head, prothorax and mesonotum pale flavotestaceous. Tegmina maculate (fig. 1, C), with conspicuous dark setigerous granules on veins. Tegminal maculations confined largely to areas between veins, veins white; maculations mostly dark brown, but each tegmen with two conspicuously darker spots, one on the commissural margin about midway between base and apex, and one near the apical margin usually confined within the hindmost of the two elongate median anal cells; pale areas of tegmina semitransparent, usually a pale milky white due to presence of a film of wax over the tegmina. Face and antennae (fig. 1, B) mostly pale brown; a broad pale band across front and genae extending from lower margin of eyes to upper margin of clypeus; lower margin of basal segment of antennae and sensoria of second segment pale. Legs largely pale with conspicuous diagonal black bands, 2 on each tibia, 1 on basal segment of each tarsus. Tips of tibial spines, calcar teeth and tarsal claws black. Venter of abdomen mostly pale, ventral surface of genital capsule black.

Front with a single unforked median carina; minimum width of vertex between eyes about 0.3 mm.; width of head across eyes about 0.9 mm. Antennae (fig. 1, A, B) unusually large; basal segment about 0.33 mm. long by 0.30 mm. maximum width, strongly flattened; 2nd segment about 0.53 mm. long by 0.26 mm. maximum width, subcylindrical, but with a flat, flange-like lower margin. Calcar of hind tibia with about 9 teeth.

Pygophore with a pair of anal spines but without lateral spines or accessory spine-like processes behind genital styles. Anal style small, pale; genital style

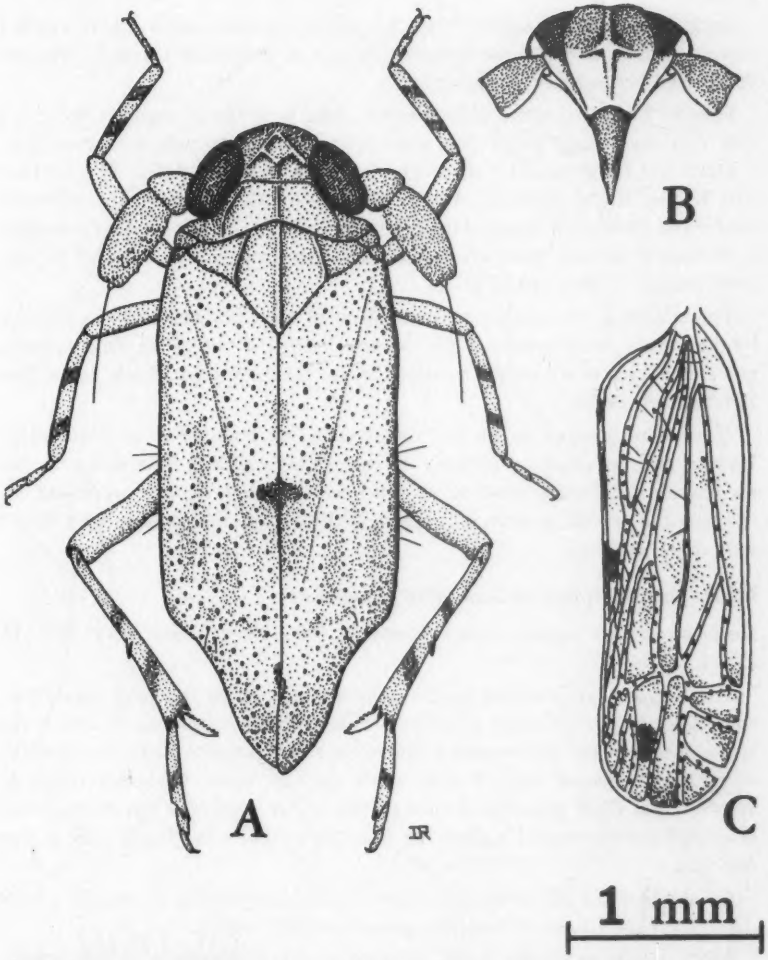

FIGURE 1. *Nesothoë magnacornis* n.sp.: A, dorsal aspect; B, frontal view of face; C. tegmen.

as figured (fig. 2, B); aedeagus (fig. 2, A) elongate, slender, terminating in a pair of slender elongate lateral processes and a somewhat shorter median dorsal process.

Body form robust; length to tips of tegmina 3.4 mm.; width across tegmina about 1.3 mm., width across posterior margin of pronotum 1.0 mm.; tegmina constricted before apices as figured.

Female. Similar to male, slightly larger; length to tips of tegmina about 4.0 mm. Anal style small, single; pale areas of body flavous to pale flavotestaceous.

Described from 20 adult specimens, 3 males and 17 females: Milolii Trail near Kokee, Kauai, 3,000 ft., August 30, 1959 (J. W. Beardsley), on *Claoxylon sandwicense* Mueller of Argau. Holotype male, allotype female, and 14 paratypes in Bernice P. Bishop Museum, Honolulu; 4 paratypes in collection of Experiment Station, HSPA, Honolulu.

This species is immediately separable from all other known Hawaiian *Nesothoë* by the extreme development of the antennae. The structure of the male genitalia and other features are similar to other broad, robust species of the genus (see Zimmerman, 1948).

Nesothoë magnacornis is the first delphacid to be reported from *Claoxylon* in Hawaii, and the observed presence of nymphs as well as adults indicates that the species is definitely attached to that host. Although *C. sandwicense* was encountered at several spots in the vicinity of Kokee, the leafhoppers were found only in the one area.

Dictyophorodelphax zwaluwenburgi Beardsley

Dictyophorodelphax zwaluwenburgi Beardsley, 1956. PROC. HAW. ENT. SOC. 16 (1):21.

This species was described from a unique female taken sweeping vegetation, and therefore not definitely associated with its host. I was able to revisit the type locality in 1959, and secured a series of 26 adult specimens and a few nymphs, all within an area of about 3 acres where the host plant, *Euphorbia celastroides* Boissier, was fairly plentiful. Although this native *Euphorbia* was encountered at other localities around Kokee, the *Dictyophorodelphax* was found only at this one spot.

On the basis of this additional material it is now possible to present a brief description and figures of the male genitalia of this species.

Male. Similar to female in size, coloration, and development of the cephalic horn; tegmina slightly smaller, each about 1.8 mm. long by 0.7 mm. wide.

Aedeagus as figured (fig. 2, D), outer surface of distal lobe with a conspicuous patch of small teeth in the area before the apex, apex bare; a short, truncate process present basad of the outer lobe, its outermost corner bearing a few denticles slightly smaller than those on the outer lobe. Genital style as figured (fig. 2, C).

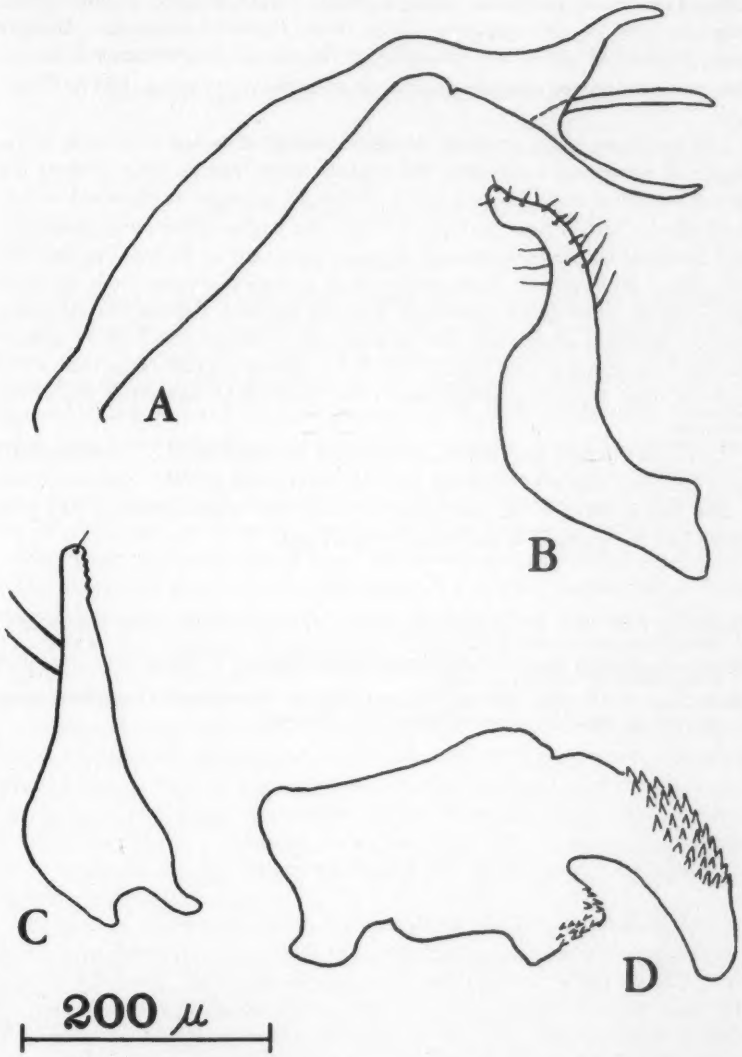

FIGURE 2. A, aedeagus of *Nesothoë magnacornis* n.sp.; B, right genital style of *N. magnacornis*; C, left genital style of *Dictyophorodelphax zwaluwenburgi* Beardsley; D, aedeagus of *D. zwaluwenburgi*.

Based on 3 male specimens: along highway, 2 miles south of Kokee, Kauai, Aug. 29, 1959 (J. W. Beardsley), swept from *Euphorbia celastroides*. Allotype male, 2 paratype males, and 18 topotype females in B. P. Bishop Museum, Honolulu; 5 topotype females in collection of Experiment Station, HSPA, Honolulu.

The specimens which comprise the series studied show some variation in the degree of downward bending of the cephalic horn, and in most of these the horn is somewhat more deflexed than in the female holotype. In those individuals in which the horn is most strongly deflexed, the degree of bending approaches that exhibited by the least strongly deflexed specimens of *D. praedicta* Bridwell from Maui. However, *D. zwaluwenburgi* may be separated easily from the latter species by its much darker coloration, narrower tegmina, and the conspicuously different aedeagus of the male (see Zimmerman, 1948, pp. 167–170). *D. usingeri* Swezey from Lanai is also similar, but has a shorter cephalic horn and wider tegmina than does *D. zwaluwenburgi*. The male of *D. usingeri* is apparently unknown.

Although the dark granules on the veins of the tegmina of *D. zwaluwenburgi* were described originally as being non-setigerous, each granule usually supports a dark seta in most of the specimens at hand. The setae apparently had been rubbed off the granules in the holotype specimen.

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A Preliminary Study of the Males of Some Hawaiian Mealybugs (Homoptera: Pseudococcidae)

JOHN W. BEARDSLEY
EXPERIMENT STATION, HSPA
HONOLULU, HAWAII
(*Submitted for publication December, 1959*)

INTRODUCTION

The systematics of the Coccoidea is based almost entirely upon characters of the adult females, and only a few attempts have thus far been made to utilize those of the male sex. Morrison (1928) made considerable use of males in his classic treatment of the Margarodidae, and Borchsenius (1957) described and figured available males of Russian Coccidae. Recently, Bustshik (1958) has provided figures and descriptions of the males of Russian species of Diaspididae, as well as keys to genera and species based on the males. With the exceptions of these papers, treatment of male scale insects has been confined largely to morphological studies and an occasional description of an individual species.

Among the more important papers dealing with male mealybugs are those of Mäkel (1942) and Jancke (1955). The former is a detailed morphological study of the skeletal and muscular systems based on males of three species. The latter is a study of the comparative morphology of the males of the various groups of Coccoidea, and includes descriptions of males of two species in different genera (*Phenacoccus* and *Planococcus*) of the Pseudococcidae. Recently, a thorough study in comparative external morphology of male scales has been presented by Theron (1958). He included one pseudococcid, *Planococcus citri* (Risso), among the seven species which he treated. Although fairly detailed descriptions of the males of a few species of mealybugs are available (Cottier, 1936; Morrison, 1945; Uichanco & Villanueva, 1932), no attempt has as yet been made to delineate characters which might be of value in separating and identifying genera and species of mealybug males.

The neglect of the male sex in the mealybugs and in other coccids has, no doubt, been due at least partially to the difficulties involved in securing adequate material for study. Although biological studies (James, 1937a) indicate that, in certain species at least, the sex ratio of mealybug progeny may be about 1:1, adult males are very short-lived and fragile so that, unless special effort is made to secure them, they are usually unrepresented in material collected and preserved in the field. Some species of mealybugs appear to be entirely parthenogenetic, no males being known. For example, I have obtained colonies of *Dysmicoccus brevipes* (Cockerell) from several hosts on Oahu, and no males were ever recovered.

Also, there is evidence that *Phenacoccus solani* Ferris may be entirely parthenogenetic (Lloyd, 1952). Males of the known Hawaiian representatives of the genera *Antonina*, *Geococcus*, and *Ripersiella* are unknown to me, but only limited amounts of living material of these have been examined.

Acknowledgments

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Materials and Methods

Whenever possible living material was utilized for preparation of slide mounts for study. Mealybug colonies collected in the field were held in the laboratory for several days so that freshly emerged males could be secured. In some cases it was necessary to hold material for as long as 10 or 12 days after collecting until the first males appeared. Specimens of males and associated females usually were prepared together by the method normally used in the preparation of mounts of the female mealybugs alone. It was found that satisfactory clearing could be obtained by soaking specimens for 12 to 48 hours at room temperature in 10 per cent KOH solution, and subsequently heating (but not boiling) in this solution for about 20 minutes. Male mealybugs usually cleared well without the manipulation which is frequently necessary in order to remove the body contents of the females. Staining was accomplished in an aqueous solution of basic fuchsin, and specimens were allowed to remain in the dye for 24 to 48 hours to secure the desired degree of staining. It was found that strongly stained specimens were most satisfactory for the study of such morphological features as the weakly sclerotized areas of the abdomen and the dermal discs. Males were usually mounted on slides with associated females. Fragments of #1 cover slips were used about the margins of the balsam drop on some slides to prevent crushing and distortion of the head and thorax, although once these structures had been studied on a few uncrushed specimens it was not considered necessary to handle additional material this way.

Both dorsal and ventral mounts were made whenever sufficient material was available in order to secure adequate mounts for study of the structural details of the more important morphological features, such as the shape of the penial sheath. It was found considerably more difficult to secure satisfactory mount of males than of females. For this reason ten or more male specimens of each species were mounted whenever material was adequate.

The Male of Pseudococcus adonidum (L.)

A relatively detailed description of the male of *Pseudococcus adonidum* (L.) is given here in order to consider the salient morphological features which are normally seen in slide mounted specimens of male mealybugs prepared by the method described above. The descriptions of the males of other forms which follow are limited to those characters which were found useful in separating the species studied. *Pseudococcus adonidum* was selected for detailed treatment because that species is generally accepted as the type of the genus *Pseudococcus* (see Ferris, 1950, pp. 170–171). Also, it is a common and widely distributed form. The females associated with the males upon which this description is based agree well with Ferris' (1948, 1950) concept of *P. adonidum*. The terminology employed for the various sclerites considered is adapted largely from Theron (1958), and the reader is referred to his paper and that of Mäkel (1942) for more detailed treatments of the exoskeleton and musculature of mealybug males.

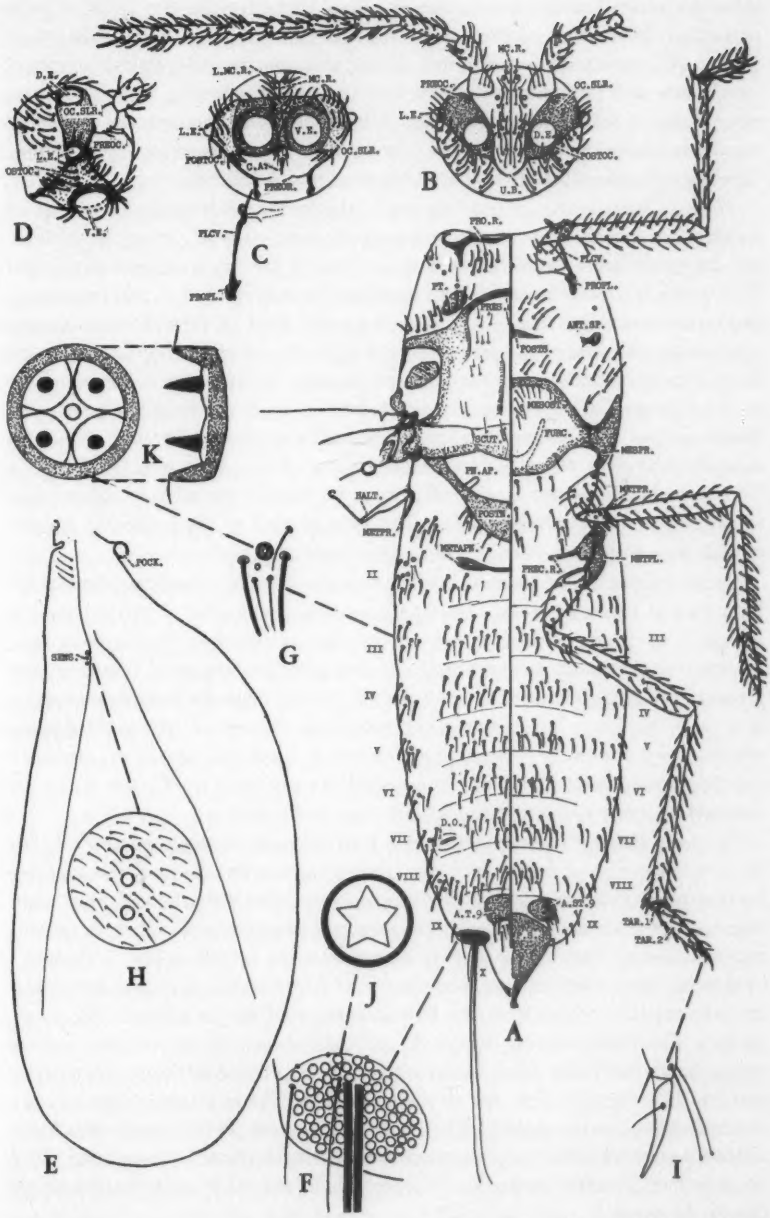
Head: According to both Mäkel and Theron the imaginal head consists mostly of epicranium, those portions of the head associated with the mouthparts in other groups having largely degenerated. Functional mouthparts are entirely lacking, and the mouth is represented by a barely discernible circular opening near the posterior margin of the venter of the head. Anterior to the mouth there is sometimes discernible a midventral longitudinal fold, termed the cranial apophysis by Theron (fig. 1, C, c.a). The head bears three pairs of conspicuous simple eyes; one pair ventrally, one pair laterally, and one pair dorsally. The three eyes of each side of the head are enclosed within a single sclerotized plate, termed the ocular sclerite by Theron (fig. 1, B,C,D, oc.slr.), and the two plates are broadly fused at their juncture between the ventral eyes. In *P. adonidum* the part of each ocular sclerite around the ventral eye, and the area extending dorsad from the lateral eye and enclosing the dorsal eye, are noticeably more heavily sclerotized than the intervening area. In some other species the ocular sclerites are more uniformly developed. A thickened ridge or band, the postocular ridge of Theron, (fig. 1, B,C,D, postoc.), extends along the posterior margin of each ocular sclerite from just behind the dorsal eye to the region behind the ventral eye, where its posteriorly directed apex forms an articulation with the cervical sclerite. A weak, mesally directed extension of each postocular ridge, behind the ventral eye, is termed the preoral ridge by Theron (fig. 1, C, preor.). A thickened preocular ridge (fig. 1, B,D, preoc.) arises from each postocular ridge at the posterio-ventral corner of each lateral eye, and extends dorsally along the anterior margin of each ocular sclerite. In *P. adonidum*, the dorsal lobes of the two ocular sclerites appear to be united by a weak, sometimes interrupted, U-shaped band (fig. 1, B, u.b.) which extends around the posterior end of a well-defined midcranial ridge or suture (fig. 1, B, mc.r.). Although it is figured by Mäkel, Theron did not find this band complete in *Planococcus citri* males, and he figures instead a pair of arcuate "meniscate bands" which mark

the posterior margin of an elongate dorsomedial sclerite. Although this dorsomedial sclerite is present in my preparations of *P. citri*, it is not discernible in specimens of *P. adonidum*. In the other species studied this sclerite showed varying degrees of development, often being represented by an area of weak sclerotization on each side of a well-developed midcranial ridge. The midcranial ridge in *P. adonidum* extends from near the center of the dorsal U-shaped band down the front of the face between the antennae where it terminates slightly below the level of the antennal condyles, between the diverging arms of a shallowly Y-shaped band. The stem of this Y-shaped band is formed by a prominent medio-ventral suture which extends upward as a continuation of the ventral line of juncture of the two ocular sclerites. Theron considers this ventral band (fig. 1, C, mc.r.) to be a separated part of the midcranial suture, and the lateral arms of the "Y" (fig. 1, C, l.mc.r) as lateral branches of that suture.

The ventral eyes are the largest and are set close together near the mid-ventral juncture of the ocular plates (fig. 1, C, v.e.). The margins of the sockets of these eyes appear as conspicuous, flat, circular rims. The sockets measure about 46 μ at their greatest diameter. The dorsal eyes (fig. 1, B, d.e.) are slightly smaller and are set farther apart than are the ventral eyes. Their sockets are about 36 μ maximum diameter, and the margins of the sockets are narrower than those of the ventral eyes. The lateral eyes (fig. 1, B,C,D, l.e.) are the smallest, and protrude strongly from the sides of the head. The sockets of these eyes are not perfectly circular, but appear more nearly triangular in outline. The margins of the sockets are formed by strongly sclerotized bands, including portions of the preocular and postocular ridges which are confluent at the posterio-ventral angle of these eyes. According to Theron, the lateral eyes are persistent larval ocelli, and the dorsal and ventral eyes are vestiges of the compound eyes found in the adults of other Homoptera (see Theron, 1958, pp. 19–20). In living specimens the eyes are dark red in color, the lateral pair appearing a trifle darker than the others. The large ventral pair protrude below as conspicuous hemispheres, and, when the head is viewed from the side, these appear to be directed forward at a slight angle from the perpendicular.

The antennae (fig. 1, B.) are ten-segmented, flagellate, and are about 0.7 mm. over-all length. Each scape appears to articulate at a small projection on the preocular ridge between the dorsal and lateral eyes, but nearer the latter. The scapes are relatively short and thick (39 μ long by 42 μ maximum width at base) as in the female. The pedicels are longer, but are noticeably thicker than the flagellar segments (about 60 μ long by 36 μ maximum width). Segments 3 to 10 measure about 100:75:75:75:63:63:57:66 μ long respectively, and are all about

FIGURE 1. Male of *Pseudococcus adonidum* (L.). A, dorsal and ventral aspects of thorax and abdomen; B, dorsal aspect of head; C, ventral aspect of head; D, lateral aspect of head; E, forewing; F, tail-forming pore cluster of 9th abdominal segment; G, dermal disc and associated setae of abdomen; H, detail of microtrichia and circular sensoria on upper surface of wing; I, detail of claw of hind tarsus; J, detail of stellate pore of tail-forming cluster; K, details of dermal disc.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the same width (about 25 μ maximum). In addition to the two types of setae present on other parts of the body, the antennae bear a few noticeably longer (about 57 μ maximum length) and thicker setae on the three apical segments, usually one each on segments 8 and 9, 2 or 3 on segment 10 (fig. 1, B). These may serve some special sensory function. Similar setae are present on the apical segments of the antennae in all the species studied, and these have been termed "specialized sensory hairs" in the descriptions which follow.

Thorax: Dorsally the anterior margin of the prothorax is marked by a pair of well-defined bar-like transverse sclerites which meet, or nearly so, at the midline, but are not fused. Mäkel believed these sclerites to be cervical in origin, but Theron has interpreted these as belonging to the true prothorax, and has termed them pronotal ridges (fig. 1, A. pro.r.). Lateral arms of these sclerites extend ventrad on each side of the prothorax, the apex of each arm nearly touching the anterior portion of a long, bar-like, longitudinal sclerite which extends from each propleuron. A short, caudally directed bar extends perpendicularly from the lateral arm of each pronotal ridge about half way down the side. The long anterior extension of each propleuron (fig. 1, A,C, plcv.) in considered by Theron to be composed basally of part of the true propleuron, which is fused apically to the true cervical sclerite. The apex of each of these sclerites appears to articulate with the posterior end of the postocular ridge.

The remainder of the dorsum of the prothorax is largely unsclerotized, except for a pair of relatively weakly staining posterior patches (fig. 1, A, pt.) one on each side of the forward projecting anterior median hump of the mesothoracic prescutum. Theron considers these to be vestigial post-tergites. The prothoracic pleurites are each reduced to a small remnant which bears the fore-coxal articulation, and the long, bar-like, anterior extension. A narrow transverse sclerite, which projects roundly forward at its center, is located at about the posterior margin of the venter of the prothorax, and is considered by Theron to be the remnant of the prothoracic poststernum (fig. 1, A, posts.).

The wing-bearing mesothorax is well developed and strongly sclerotized. For detailed discussion of the comparative anatomy and morphology of this segment see Theron's (1958) description of *Planococcus citri*. The mesothoracic prescutum (fig. 1, A, pres.) is strongly humped anteriorly. The postnotum (fig. 1, A, postn.) is conspicuously developed and is separated from the scutellum (fig. 1, A, scut.) by a rather large membranous area. A pair of conspicuous postnotal apophyses extend ventrally inward from the lateral margins of the postnotum (fig. 1, A, pn.ap.). The mesosternum (fig. 1, A, mesost.) is well developed and bears a conspicuous furca (fig. 1, A, furc.) which extends internally from its posterior margin. The mesopleurites are strongly developed beneath the wings and are narrowly joined to the sides of the mesosternum below. Each mesopleurite bears a small posteriorly-directed projection (part of the thickened mesopleural ridge according to Theron) on its hind margin, which articulates with the mesocoxa (fig. 1, A, mespr.).

The metapleurites (fig. 1, A, metpl.) are present but relatively small. A well-developed metapleural ridge extends dorsally from the base of each metacoxa as a long, bar-like sclerite which reaches to the base of the halter (fig. 1, A, metpr.). There is also a slender ventral transverse extension from each metapleurite, termed the precoxal ridge by Theron (fig. 1, A, prec.r.) which reaches about half way to the mid-ventral line. There is no discernible sclerotized metasternum. The narrow transverse dorsal sclerite behind the mesopostnotum is termed the metapostnotum (fig. 1, A, metapn.) by Theron.

The legs (fig. 1, A.) are well-developed, elongate, and slender. The hind femora measure about 200 μ long by about 42 μ maximum width. The tarsi are two-segmented in *P. adonidum* and in males of all other species studied. The basal segment (fig. 1, A, tar. 1) is very small, being little more than a narrow ring, wider along its posterior face. The trochanters each bear five circular sensoria. The tarsal claws (fig. 1, I) are noticeably longer and more slender than those of the female; those of the hind tarsi measuring about 36 μ long by about 9 μ wide at the base. The digitules of the tarsal claws are short, slender, and setiform; not spatulate apically as are those of the female. The apex of the distal tarsal segment bears two slender, apically spatulate setae as in the female.

The fore-wings are well-developed in all specimens of *P. adonidum* seen. These possess two discernible longitudinal veins which are usually designated as the radius and the media. Both surfaces of the wings are densely covered with microtrichia (fig. 1, H) about 4 or 5 μ in length. A compact row of 3 or 4 circular sensoria (fig. 1, E, sens.) is located on the dorsal surface along the anterior (radius) vein just above and distad of the basal end of the posterior vein. A transverse row of 3 or 4 slender setae (fig. 1, E) each about 25 μ long, is situated on the leading edge of the anterior vein near its base.

The hind wings are reduced to a pair of halteres (fig. 1, A, halt.). These are finger-like, about 90 μ long, and each bears at its apex a single slender seta about 60 μ long, the end of which is recurved to form a conspicuous hook. A circular pocket on the posterior margin of each fore-wing (fig. 1, E, pock.) serves as a receptacle for the hook of the halter.

The two pairs of thoracic spiracles found in females are present and of similar form in the males. (Actually, these are each a spiracle plus an associated peritreme, according to Theron). The anterior (mesothoracic) pair (fig. 1, A, ant. sp.) is situated laterally below the fore end of the prescutum of the mesothorax, and slightly behind but in nearly the same horizontal plane as is the articulation of the fore coxa with the propleuron. The posterior spiracle is located almost directly ventrad of the base of the halter and about in the same horizontal plane as the articulation of the mesocoxa.

Abdomen: The abdomen consists of nine discernible segments, which appear to be homologous with the nine visible segments of the female abdomen. In the female, Ferris (1950) considers these to represent segments 2 to 9, with segment 10 reduced to a small area between the anal lobes ventrally, and to the mem-

branous area surrounding the anal ring dorsally. According to Ferris' interpretation, the posterior dorsal ostioles of the female lie in the morphological seventh abdominal segment. A pair of faint dorsal ostioles (fig. 1, A, d.o.) are present on the abdomen of males of *P. adonidum*, and in males of some other species, (e.g.: *Laminicoccus giffardi* (Ehrhorn)) these are more noticeably developed. If the posterior dorsal ostioles of the male also are assumed to lie in the seventh abdominal segment, it then appears that the second abdominal segment is the first discernible one, as in the female. By this interpretation, the tenth segment of the male abdomen is represented by the largely unsclerotized triangular area of the dorsum immediately over the ventral penial sheath. Theron considers that in *P. citri* this area consists of the fused ninth and tenth abdominal tergites, and he considers the pore clusters and associated long hairs whcih give rise to the caudal wax tails of the male to lie near the posterior margin of abdomianl segment 8. However, as I have interpreted abdominal segmentation, these structures are located on the posterior margin of segment 9 in *P. adonidum*, and in all other species studied (excepting *Phenococcus gossypii* Townsend & Cockerell, which possesses wax tails on segment 8 as well as segment 9).

Except for the strongly sclerotized apical penial sheath (fig. 1, A, p.s.) The abdomen is largely unsclerotized. The ventrite of the ninth abdominal segment bears a small weakly sclerotized patch on either side (fig. 1, A, a.st. 9) and the ninth tergite bears a relatively large rectangular area of similar development (fig. 1, A, a.t. 9). There is also a small weakly sclerotized patch on the middle of the dorsum of the tenth abdominal segment above the penial sheath.

The penial sheath (fig. 1, A, p.s.; fig. 2, A,B) is considered to be an apical process of the ninth abdominal segment (see Tuxen et al, 1956; pp. 152–153, fig. 191). It is heavily sclerotized, roughly triangular in outline, and measures about 155 μ long by about 140 μ maximum width. It consists of a broad ventral plate which tapers posteriorly to a narrow apical extension (fig. 2, A, ext.). The tip of the apical extension is slightly expanded, truncate, and is about 21 μ maximum width. In lateral view the tip appears to be bent upward slightly. A conspicuous longitudinal slit, which begins about half way from the base of the sheath, extends nearly to the tip of the apical extension (fig. 2, A, sl.). In many preparations the apical portion of the penis may be seen extending through this slit. A pair of finger-like median lobes, each about 36 μ long (fig. 2, A, m.l.), arise, one on each side, near the base of the median slit. From the side (fig. 2, B) these lobes appear to be directed downward at a slight angle so that the tips are somewhat below the level of the bases. The tips of the median lobes are rounded and bear several small, fine setae. The sclerotized portion of the actual penis is an elongate slender rod, the apical portion of which forms a very shallow sigmoid curve so that the tip is directed in a postero-ventral direction (fig. 2, C). According to Theron, the sclerotized portion of the penis of *P. citri* lies along the ventral margin of that organ. At its base the penis appears to be attached internally to the basal part of the ventral sheath by a broad longitudinal apodeme (fig. 2, C,

apd.) which, according to Theron, actually is the modified ventral lip of the internal genital aperture. Spermatozoa are visible within the abdomen in many male mealybug, and the structure of heads can sometimes be determined with an oil emersion objective (see Doutt, 1952).

Dermal structures: A conspicuous group of circular pores and long hairs is present on the postero-lateral margin of each side of the ninth abdominal segment. (fig. 1, A, F). These structures give rise to the prominent caudal wax tails of the living adult male mealybug. In *P. adonidum* there are two very long hairs, about 400 μ in length, a slender seta about 100 μ long, and a smaller seta about 40 μ long associated with the tail-forming pores on each side of the ninth segment. Each pore cluster contains about 60 or 70 individual pores of a type not found in the female. These pores (fig. 1, J) are circular in outline, about 6 or 7 μ in diameter, with a narrow outside rim and a five-pointed star-shaped lumen. The lumen appears to be septate internally, but the septa are too fine to determine accurately with the available magnification. These pores will subsequently be referred to as stellate pores. There are no trilocular pores, multilocular disc pores, or large tubular ducts (such as occur on the derm of the females) present in the adult males of this or any of the other species studied, although some of these structures occur in the immature stages of *P. adonidum* males (see James, 1937b). A few minute structures which appear to be extremely small, short, tubular ducts elevated on small papillae were found in the vicinity of some of the prominent dermal disc structures of the abdomen. These ducts measured about 2.5 μ in diameter and 2.5 μ in depth.

The peculiar dermal disc structures referred to above (fig. 1, K) also appear to be confined to the male sex. In *P. adonidum* these discs are found along the lateral margins of the dorsum of the abdominal segments, on the prothorax, and on the head. They are usually circular or somewhat quadrilateral in outline, and each consists of an outer rim within which are four (occasionally three or five) roughly circular peripheral loculi. In lateral view these discs appear as recessed dish-like structures. A short, stout, peg-like projection about 3 μ long, extends upward from the center of each of the peripheral loculi. A diamond-shaped loculus, within which a small central circular septum is at times discernible, occupies the central area of the disc between the peripheral loculi. The discs measure about 7 or 8 μ in outside diameter in *P. adonidum*. Whether these discs are sensory or secretory in function, or both, was not determined. Similar structures were found in males of all other species studied, although these sometimes differed in the number of peripheral loculi present, and often were noticeably smaller than those of *P. adonidum*. A few, very small, simple, circular pores, about 3 μ in diameter, are present on the dorsum at the margins of the clusters of stellate pores and along the lateral margins of the anterior abdominal segment in the vicinity of the dermal discs (fig. 1, G).

Both dorsum and venter are clothed with conspicuous setae which are of two distinct types, a relatively thick, finger-like form (digitiform setae) which are

not found on the female, and the usual type of slender filamentous setae. Of these, the digitiform type is more numerous. These are about 26 to 30 μ long and of nearly uniform thickness throughout, with an acute tip (fig. 1, G). These setae are not found on the heavily sclerotized parts of the mesothorax or the penial sheath. The less numerous slender setae vary in length from about 15 to 30 μ (fig. 1, G). The setae of the head, antennae, and legs are of both types with the digitiform predominating. Digitiform setae of the antennae and legs are a trifle longer than those of the body, reaching about 36 μ maximum length.

Comparison of Males of Thirty Species Found in Hawaii

Males of 30 described species, including representatives of 13 described genera were obtained for study. The bulk of the specimens studied were obtained either from fresh field-collected and laboratory-reared material, or from dried *in situ* material in the collection of the Experiment Station, HSPA. Males of one peculiar endemic form, *Phylococcus oahuensis* (Ehrhorn), were obtained from leaf galls on specimens of the host plant housed in the herbarium of the Bernice P. Bishop Museum.

With the exception of two closely related species of *Pedronia*, it was possible to separate the species studied satisfactorily on the basis of characters present in the male sex. The structure found most useful in separating the males was the apical penial sheath. The penial sheaths of nearly all the species considered have been illustrated in figures 2 and 3. The shape of the ventral sclerotized portion of the penis may also prove to be of taxonomic value. However, as this structure was frequently obscured by the heavily sclerotized penial sheath in my preparations, no attempt has been made to utilize it here. Body size, lengths of appendages, and the diameters of the dorsal and ventral eyes were all found to be of some value in separating species. The distribution of patches of weak sclerotization on the abdominal segments was also sometimes useful, but it was necessary that the specimens be very well stained for the proper detection of these areas. The form, size, number and distribution of small dermal structures (pores, dermal discs, and setae) were also utilized, but the amount of interspecific variation exhibited by such structures was found to be much less marked in the male sex than in the females.

Fully winged males were found in every species studied. However, in one species, *Saccharicoccus sacchari* (Cockerell), completely apterous males were also encountered, and in another species, *Palmicola palmarum* (Ehrhorn), brachypterous males with reduced, non-funcitonal wings occurred together with ma-

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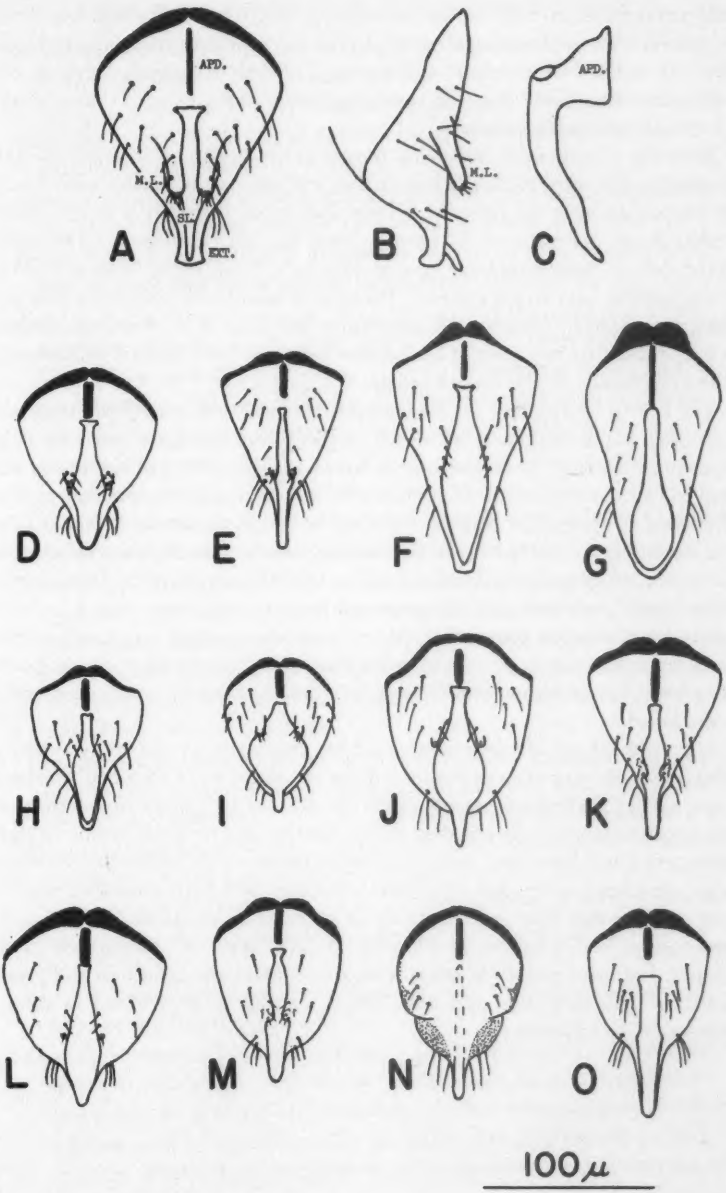
FIGURE 2. A, ventral aspect of penial sheath of *Pseudococcus adonidum*; B, lateral view of same; C, lateral aspect of penis of *P. adonidum*. Ventral aspects of penial sheaths of: D, *Clavicoccus tribulus;* E, *Dysmicoccus boninsis;* F, *D. neobrevipes;* G, *Ferrisiana virgata;* H, *Nesococcus pipturi;* I, *Nipaecoccus nipae*; J, *N. vastator;* K, *Pedronia acanthocauda;* L, *P. cibotii;* M, *P. hawaiiensis;* N, *Phenacoccus gossypii;* O, *Phylococcus oahuensis.*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cropterous males. In these two species males lacking functional wings were found to possess fewer antennal segments than their macropterous counterparts. Generally, the number of antennal segments was of little taxonomic value as only rarely were there fewer than the basic number of 10 segments. In no case were more than 10 segments found.

With the exception of *Phenacoccus gossypii* Townsend and Cockerell, all of the species studied were found to possess but a single pair of caudal wax tails. In *P. gossypii* wax tails are present on both abdominal segments 8 and 9. Jancke (1955) shows two pairs of tail-forming setae and associated pores in his figure of the male of *Phenacoccus piceae* Low, and Green's (1922) figure of the male of his *P. insolitus* also has two pairs of tails. The male of *Heterococcus graminicola* Morrison (Morrison, 1945) is described as possessing two pairs of tail-forming "cerarii". It is possible that two pairs of caudal wax tails may be of general occurrence in males of *Phenacoccus* and related genera.

The key to species and the descriptions which follow are offered somewhat hesitantly as the treatments of several of those considered are based on rather inadequate material. In several species where adequate series of specimens were studied, a certain amount of intraspecific variation was encountered in such characters as appendage lengths, the number and distribution of dermal discs, and the size and development of sclerotized areas. In view of this variability, the measurements given in the descriptions should not be interpreted as defining exact limits. Such measurements are presented because they were found to be of considerable value in comparing species, particularly where interspecific differences were relatively large. It is possible that it will become necessary to modify the present key when additional material of the more poorly represented species is examined.

The males of the species which have been considered in this study appear to offer less in the way of interspecific differences than is to be found in females of these species. Differences which might be deemed of generic significance are less apparent in the male sex than in the females, and without exception those characters which have been utilized to define genera in the female sex are absent or greatly altered in the male sex. When the males have been adequately studied, it is possible that they will prove to be of value in elucidating phylogenetic relationships and, perhaps, in bringing to light cases of convergence in the females. For these reasons it seems wise to encourage the collection and preservation of male mealybug specimens whenever these can be found in definite association with females.

KEY TO THE KNOWN MALES OF HAWAIIAN MEALYBUGS

1. Abdomen with two pairs of tail-forming pore clusters and associated long hairs, one pair each on segments 8 and 9 ..... **Phenacoccus gossypii** Townsend & Cockerell

   Abdomen with a single pair of tail-forming pore clusters and associated long hairs on segment 9 2

2. Apex of penial sheath broadly truncate or nearly so, usually expanded slightly at tip; median lobes of sheath conspicuously developed 3

   Apex of penial sheath usually rounded or pointed, if truncate then with median lobes very much reduced or absent 7

3. Apex of sheath relatively narrow, about 10 μ wide at expanded part of tip; antennae relatively short, about 425 μ long; abdomen with slender filamentous setae only ..... **Pseudococcus floriger** Ferris

   Apex of sheath wider, 20 μ or more wide at expanded part of tip; antennae relatively long, 600 μ or longer; abdomen with both digitiform and slender filamentous setae 4

4. Apex of penial sheath relatively very wide, about 35 or 36 μ across expanded portion ..... **Pseudococcus dorsispinosus** Beardsley

   Apex of penial sheath narrower, less than 30 μ across expanded portion 5

5. Apex of penial sheath about 21 μ wide across expanded portion; digitiform setae relatively numerous on dorsum of abdomen, more plentiful than slender filamentous setae ..... **Pseudococcus adonidum** (L.)

   Apex of penial sheath wider, 24 μ or more across expanded portion; digitiform setae of dorsum of abdomen relatively sparse, less numerous than slender filamentous setae 6

6. Apex of penial sheath about 24 or 25 μ wide across expanded portion; eyes smaller, dorsal pair each about 32 μ in diameter, ventral pair each about 36 μ in diameter ..... **Pseudococcus lycopodii** Beardsley

   Apex of penial sheath about 27 or 28 μ wide across expanded portion; eyes larger, dorsal pair each about 39 μ in diameter, ventral pair each about 42 μ in diameter ..... **Pseudococcus antricolens** Ferris

7. Apex of penial sheath relatively broadly rounded, width at 9 μ before tip 22 μ or more 8

   Apex of penial sheath relatively finely pointed or somewhat truncate, width at 9 μ before tip 16 μ or less 11

8. Digitiform setae of legs and abdomen very long, those of hind femora about 60 μ in length; dermal discs of abdomen all with 3 peripheral loculi, appearing triangular in outline ..... **Ferrisiana virgata** (Cockerell)

   Digitiform setae of appendages shorter, those of hind femora about 30 μ or less in length, most dermal discs with 4 peripheral loculi, occasionally with 3 or 5 9

9. Penal sheath relatively short, about 135 μ over-all length (fig. 3, I) ..... **Pseudococcus montanus** Ehrhorn
Penial sheath longer, 170 μ or more over-all length 10

10. Penial sheath very long, about 200 μ over-all length, apical portion evenly tapered, not swollen before tip (fig. 3, C); dorsum of anterior abdominal segments without discernible sclerotized patches ..... **Pseudococcus citriculus** Green
Penial sheath shorter, about 175 μ over-all length, apical portion slightly expanded before tip (fig. 3, H); dorsum of anterior abdominal segments with small paired patches of weak sclerotization ..... **Pseudococcus maritimus** (Ehrhorn)

11. Dermal discs of abdomen with from 5 to 7 peripheral loculi 12
Dermal discs of abdomen mostly with 4 peripheral loculi, occasionally with 3 or 5, discs sometimes apparently lacking in one species 13

12. Antennae very long, nearly 1 mm. total length; eyes very large, dorsal and ventral both about 60 μ diameter ... **Nipaecoccus vastator** (Maskell)
Antennae shorter, about 0.5 to 0.6 mm. total length, eyes smaller, dorsal about 30 μ diameter, ventral about 33 μ diameter ..... **Nipaecoccus nipae** (Maskell)

13. Digitiform setae of abdomen relatively plentiful, usually more numerous on venter than on dorsum 14
Digitiform setae absent on abdomen, or, if present, not more than about 10 discernible 17

14. Apical portion of penial sheath forming a relatively fine slender point, 6 to 8 μ wide at 9 μ before tip 15
Apical portion of penial sheath wider, 12 to 16 μ wide at 9 μ before tip ... 16

15. Antennae 8- or 9-segmented, very short (not more than about 0.35 mm. total length); dorsal digitiform setae of abdomen short, 12 to 14 μ in length; both macropterous and brachypterous forms known ..... **Palmicola palmarum** (Ehrhorn)
Antennae 10-segmented, longer (about 0.6 to 0.65 mm. total length); dorsal digitiform setae of abdomen longer, mostly 24 to 30 μ in length; macropterous form only known ..... **Dysmicoccus boninsis** (Kuwana)

16. Penial sheath relatively long, about 145 μ over-all length, median lobes apparently lacking (fig. 2, F) ..... **Dysmicoccus neobrevipes** Beardsley
Penial sheath shorter, about 100 μ over-all length, median lobes represented by a pair of small humps (fig. 2, D) ... **Clavicoccus tribulus** Ferris

17. Completely apterous, without vestiges of wings; sclerites of thorax not developed ..... apterous form of **Saccharicoccus sacchari** (Cockerell)
Macropterous; thorax developed normally 18

18. Digitiform setae of antennae relatively short, maximum length 18 μ or less 19

Digitiform setae of antennae longer, maximum length 25 μ or more....21

19. Penial sheath about 140 μ over-all length, apex about 14 μ wide at 9 μ before tip, without discernible median lobes (fig. 3, F)..... .....**Laminicoccus giffardi** (Ehrhorn)

Penial sheath about 110 μ or less over-all length, apex 10 μ or less in width at 9 μ before tip, a small pair of median lobes present.....20

20. Digitiform setae of antennae very short, 10 μ or less in length; legs and antennae relatively short (antennae about 0.43 mm. long, hind femora about 115 μ long.....**Trionymus rostellum** Lobdell

Digitiform setae of antennae longer, 15 to 18 μ in length; legs and antennae longer (antennae about 0.55 mm. or more long, hind femora about 150 μ long).....**Trionymus lounsburyi** Brain

21. Posterior portion of penial sheath moderately elongate, apex slightly expanded before tip, tip rounded, margins of ventral slit becoming abruptly transverse so as to form approximately right angles at about half way between base and apex (fig. 3, L.); dermal discs present on midventral areas of several abdominal segments..... .....alate form of **Saccharicoccus sacchari** (Cockerell)

Penial sheath not so formed; dermal discs of abdomen confined to lateral margins of segments 22

22. Venter of abdomen with large median sclerotized patches on segments 5 to 9, and similar less strongly sclerotized patches on segments 2 to 4; dorsum of abdomen with similar patches on segments 7 to 9 and sometimes 6.....**Pedronia acanthocauda** Beardsley

Without such sclerotized patches, patches of abdomen when present smaller, less strongly developed, and involving fewer segments.....23

23. Apex of penial sheath in form of a fine slender point about 6 or 7 μ wide at 9 μ before tip, sheath without discernible median lobes (fig. 3, K); dermal discs of abdomen reduced to not more than 2 or 3 on each side, sometimes apparently absent; digitiform setae wanting on abdomen, slender setae of venter of abdomen very long, nearly 50 μ maximum length.....**Pseudococcus straussiae** Ehrhorn

Without the above combination of characters.....24

24. Apical portion of penial sheath relatively elongate, about one-half as long as the basal portion (fig. 2, O)..**Phylococcus oahuensis** (Ehrhorn)

Apical portion of penial sheath less noticeably elongate.....25

25. Penial sheath without discernible median lobes.....26

Penial sheath with a pair of small median lobes or rounded protuberances..28

26. Penial sheath relatively long, about 145 μ over-all length (fig. 3, N).... .....**Trionymus multiductus** Beardsley

Penial sheath shorter, 120 μ or less over-all length.....27

27. Claws of hind tarsi about 45 μ long; digitiform setae present on abdomen ..... **Nesococcus pipturi** Ehrhorn

Claws of hind tarsi shorter, about 28 μ long; abdomen without digitiform setae ..... **Trionymus refertus** Ferris

28. Claws of hind tarsi about 40 μ long; dermal discs of abdomen relatively numerous, usually 3 or 4 per segment on each side; abdomen without digitiform setae ..... **Planococcus citri** (Risso)

Claws of hind tarsi shorter, about 30 μ long or less; dermal discs of abdomen less numerous, not more than 1 or 2 per segment on each side; a few digitiform setae usually present on venter of abdomen 29

29. Antennae relatively short, total length about 0.45 mm., 3rd segment about 50 μ long ..... **Pedronia crypta** Beardsley

Antennae longer, 0.54 to 0.6 mm. total length, 3rd segment about 75 μ or more long ..... **Pedronia cibotii** Beardsley and **Pedronia hawaiiensis** Ferris

Clavicoccus tribulus Ferris

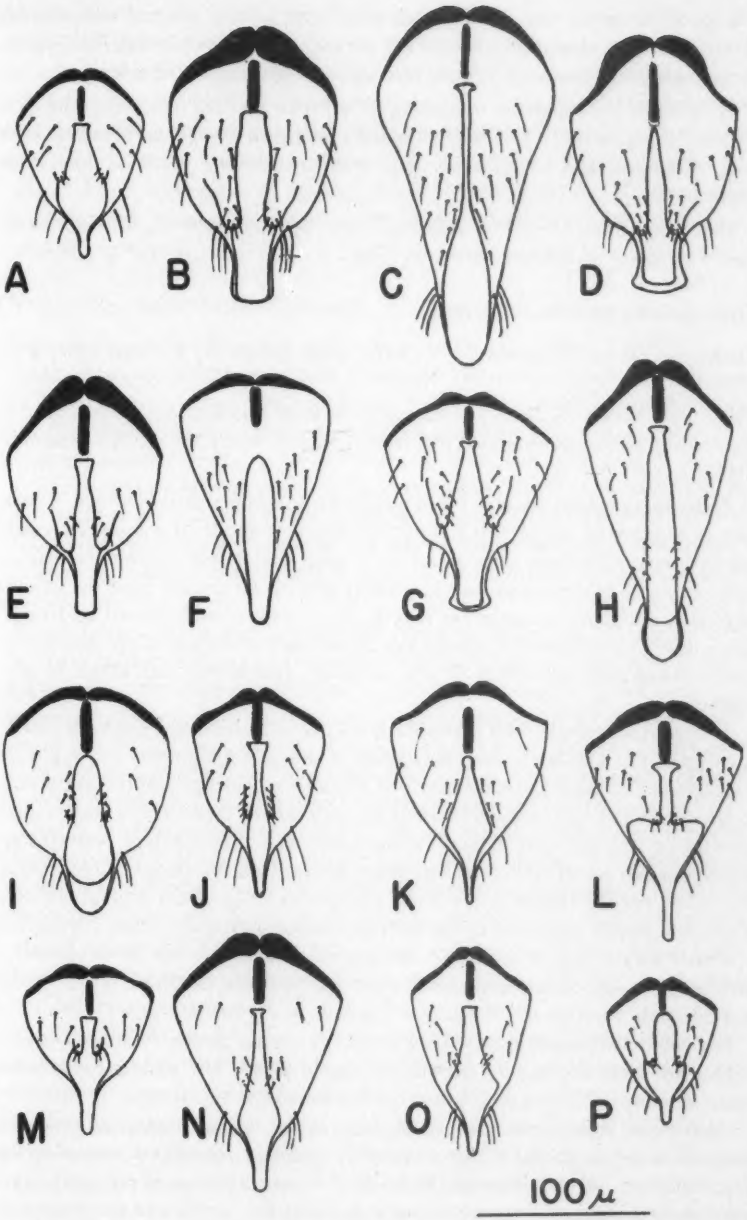
Clavicoccus tribulus Ferris, 1948. Ins. Hawaii 5:174, fig. 99.

Male. Body length about 1.05 mm.; available specimens macropterous. Antennae 10-segmented, about 580 μ total length; 3rd segment about 75 μ long. Antennae clothed with digitiform setae about 42 μ maximum length, plus slender filamentous setae about 48 μ maximum length. Thicker specialized sensory hairs on 3 apical segments about 80 μ maximum length. Head with a sharply defined midcranial ridge; without a noticeably developed dorsomedial sclerite. Eyes moderately large, dorsal pair each about 42 μ in diameter, ventral pair each about 48 μ in diameter.

Dermal discs mostly with 4 peripheral loculi, some with 5; one each side of segments 3 to 8, sometimes with one or more segments without discs on one or both sides; 4 to 6 on each side of segment 2; 3 or 4 on venter of metathorax; 6 to 8 on each side of prothorax; and 1 or 2 on each side of anterior part of head between antennae. Tail-forming pore clusters confined to pair on 9th abdominal segment; each cluster consisting of 35 to 45 stellate pores. Body clothed with slender filamentous setae about 30 μ maximum length, plus digitiform setae about 24 μ maximum length. Digitiform setae present on both surfaces of abdomen, more numerous on venter.

Penial sheath (fig. 2, D) about 100 μ total length; with a pair of small but readily discernible median lobes; posterior portion tapering to a rounded apex, about 15 μ wide at 9 μ before tip.

Figure 3. Ventral aspects of penial sheaths of: A, *Planococcus citri;* B, *Pseudococcus antricolens;* C, *P. citriculus;* D, *P. dorsispinosus;* E, *P. floriger;* F, *Laminicoccus giffardi;* G, *Pseudococcus lycopodii;* H, *P. maritimus;* I, *P. montanus;* J, *Palmicola palmarum;* K, *Pseudococcus straussiae;* L, *Saccharicoccus sacchari;* M, *Trionymus lounsburyi;* N, *T. multiductus;* O, *T. refertus;* P, *T. rostellum.*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Legs of moderate size, hind femora about 205 μ long; clothed with slender digitiform setae about 24 μ maximum length, plus a few slender filamentous setae about 30 μ maximum length. Claw of hind tarsus about 40 μ long.

Abdominal sclerotization consisting of a broad median transverse patch on dorsum of segment 9; a pair of small patches on venter of segment 9, one on each side of midline; and a moderately large median transverse patch on dorsum of segment 8.

Based on 4 specimens: Mt. Tantalus, Oahu, June 20, 1959 (J. W. Beardsley), reared ex leaves of *Hibiscus arnottianus* Gray.

Dysmicoccus boninsis (Kuwana)

Dactylopius (*Pseudococcus*) *boninsis* Kuwana, 1909. Jour. New York Ent. Soc. 17:161.

Pseudococcus boninsis (Kuwana) Morrison, 1929. Jour. Ag. Res. 31(5):489, figs. 2, 3.
Dysmicoccus boninsis (Kuwana) Ferris, 1950 Atlas of Scale Ins. of No. America 5:57, fig. 18.

Male. Body length about 1.1 mm.; available specimens macropterous. Antennae 10-segmented, about 630 μ long; 3rd segment about 70 μ long. Antennae clothed with digitiform setae about 36 μ long, plus a few slender filamentous setae about 60 μ maximum length. Thicker specialized sensory hairs on 3 apical segments about 60 μ maximum length. Head with a well defined midcranial ridge dorsally; dorsomedial sclerite not appreciably developed. Eyes moderately small, dorsal pair each about 30 μ in diameter, ventral pair each about 36 μ in diameter.

Dermal discs mostly with 4 peripheral loculi, and occasional one with 3 or 5; a group of 1 to 4 on lateral margins of each of abdominal segments 2 to 8, groups on segments 2, 7 and 8 usually with 1 or 2 more discs than groups on intervening segments. A few discs (usually 6 to 8) on each side of prothorax; a pair of discs usually on anterior part of head between antennae. Tail-forming pore clusters limited to pair on 9th abdominal segment; each cluster composed of about 60 to 70 closely packed stellate pores. Body clothed with digitiform setae about 30 μ maximum length, plus slender filamentous setae of comparable length or shorter.

Penial sheath (fig. 2, E) about 110 μ total length; median lobes absent or reduced to a pair of barely discernible humps; posterior extension slender, with a moderately truncate tip, about 6 or 7 μ wide at 9 μ before tip.

Legs of moderate size, hind femora about 175 μ long; clothed with conspicuous digitiform setae about 30 μ maximum length, plus a few slender filamentous setae of comparable length. Claw of hind tarsus about 35 μ long.

Abdominal sclerotization consisting of a broad median transverse patch on dorsum of 9th segment; a pair of roughly quadrate patches on venter of 9th segment, one on each side of the midline; 2 medially interrupted transverse patches on dorsum of segment 8, one at the anterior margin and the other near

the posterior margin; and a pair of transverse patches, one on each side of the midline, along the posterior margin on the dorsum of segments 2 to 6, these becoming progressively smaller and weaker posteriorly; dorsum of segment 7 with small irregular patches around the bases of some setae. Other abdominal setae, both dorsal and ventral, with well defined narrow rings of sclerotization about their bases.

Based on 13 specimens: 8, Waialua, Oahu, March, 1959 (J. W. Beardsley), reared ex sugar cane; 5, Honolulu, Oahu, May 13, 1958 (J. W. Beardsley), reared ex sugar cane.

Dysmicoccus neobrevipes Beardsley

Dysmicoccus neobrevipes Beardsley, 1959. PROC. HAW. ENT. SOC. 17(1):31, fig. 1.

Male. Body length about 1.0 mm.; available specimens macropterous. Antennae 10-segmented, about 530 μ long; 3rd segment about 70 μ long. Antennae with both digitiform and slender filamentous setae; digitiform setae about 27 μ maximum length, slender setae up to about 45 μ maximum length. Thicker specialized sensory hairs on 3 apical segments up to about 45 μ maximum length. Head without a well-developed dorsomedial sclerite, with a fairly well-defined midcranial ridge extending dorsally to a point between the dorsal eyes. Eyes of moderate size, dorsal pair each about 30 μ in diameter, ventral pair each about 33 μ in diameter.

Dermal discs mostly with 4 peripheral loculi, an occasional one with 3 or 5; 1 to 3 on each side of each of several abdominal segments. Segments 7 and 8 usually with 2 or 3 discs on each side, segments 3 to 6 with 1, 2, or no discs per side, a larger group of 6 to 10 discs on each side of segment 2. One disc usually present just behind each thoracic spiracle; 10 to 15 or so discs on each side of prothorax; occasionally 1 or 2 discs on venter of pro- and meta-thorax between legs. One or two discs usually present on anterior part of head between antennae. Tail-forming pore clusters restricted to pair on 9th abdominal segment; each cluster composed of about 40 stellate pores. Body clothed with interspersed digitiform and slender filamentous setae, the former predominating. Digitiform setae mostly about 20 μ long; slender setae up to about 24 μ maximum length.

Penial sheath (fig. 2, F) about 145 μ long; without discernible median lobes; posterior portion evenly tapered to a blunt, nearly truncate apex about 16 μ wide at 9 μ before tip.

Legs of moderate length, hind femora about 180 μ long; clothed with digitiform setae about 24 μ maximum length plus slender filamentous setae 21 μ maximum length. Claw of hind tarsus about 36 μ long.

Abdominal sclerotization consisting of a broad transverse patch on dorsum of 9th segment; a small patch on each side of the venter of the 9th segment near the base of the penial sheath; a pair of interrupted transverse patches on dorsum of segment 8, one on the anterior margin, the other near the posterior margin; a

pair of small transverse patches on posterior margin of dorsum of segment 2; occasionally a smaller weaker pair at the same position on segment 3. Posterior dorsal ostioles well-developed.

Based on about 15 specimens: Aina Haina, Oahu, Feb.–May, 1958 (J. W. Beardsley), on *Agave sisalana* (Engelm.) Perrine.

Ferrisiana virgata (Cockerell)

Dactylopius virgatus Cockerell, 1893. ENTOMOLOGIST 26:178.
Pseudococcus virgatus (Cockerell) Ferris, 1919. JOUR. ECON. ENT. 12(4):297, fig. 17.
Ferrisia virgatus (Cockerell) Fullaway, 1923. PROC. HAW. ENT. SOC. 5(2):311.
Ferrisiana virgata (Cockerell) Takahashi, 1929. TRANS. NAT. HIST. SOC. FORMOSA 19(104):429.

Male. Body length about 1.4 mm.; available specimens macropterous. Antennae 10-segmented, about 770 μ over-all length; 3rd segment about 120 μ long. Antennae clothed with slender digitiform setae 45 to 50 μ long; slender filamentous setae very scarce, usually but 1 or 2 on basal segments. Thicker specialized sensory hairs of 3 apical segments about 65 μ maximum length.

Head with a moderately well developed dorsomedial sclerite. Eyes moderately large, dorsal pair each about 40 μ in diameter, ventral pair each about 50 μ in diameter.

Dermal discs triangular in outline, with three peripheral loculi; 1 or occasionally 2 on each side of abdominal segments 3 to 7; 1 or 2 behind each spiracle; 1 or 2 on each anterior lateral angle of the prothorax. Tail-forming pore clusters limited to pair on 9th abdominal segment; each cluster containing about 50 closely packed stellate pores. Body sparsely clothed with slender filamentous setae mostly 25 to 30 μ long. Digitiform setae absent except on antennae and legs.

Penial sheath (fig. 2, G) about 150 μ over-all length; without discernible median lobes; tapering posteriorly to a broadly rounded apex about 25 μ wide at 9 μ before tip.

Legs relatively long, hind femora about 270 μ in length; clothed with very long digitiform setae, mostly 65 to 80 μ in length, plus a very few small slender setae about 15 μ or less in length. Claw of hind tarsus about 37 μ long.

Abdominal sclerotization consisting of a broad median transverse patch on dorsum of segment 9, plus a pair of small areas on venter of segment 9, one on each side of the midline. Dorsum of segment 8 with two interrupted transverse sclerotized areas, the more distinct one near the posterior margin, the anterior one much less distinct and broadly interrupted at its center. A pair of well-defined transverse streaks, one on each side of the midline, near the posterior margin of the dorsum of segment 2, plus a much smaller, weaker pair of streaks in the same position on segment 3. Bases of abdominal setae, particularly those of the posterior segments, surrounded by narrow rings of sclerotization.

Based on 6 specimens: Honolulu, Oahu, April 1959 (J. W. Beardsley), on leaves of croton.

Pedronia acanthocauda Beardsley

Pedronia acanthocauda Beardsley, 1957. PROC. HAW. ENT. SOC. 16(2):230, fig. 5.

Male. Body length about 1.1 mm.; available specimens macropterous. Antennae 10-segmented, about 560 μ total length; 3rd segment about 80 μ long. Antennae clothed with digitiform setae about 35 μ maximum length, plus a few slender filamentous setae about 60 μ maximum length. Three apical segments with slightly thicker specialized sensory setae about 40 μ maximum length. Head with a weak midcranial ridge dorsally; dorsomedial sclerite not noticeably developed. Eyes relatively small, dorsal pair each about 23 μ in diameter, ventral pair each about 26 μ in diameter.

Dermal discs very few, those present with 4 peripheral loculi; distributed along lateral margins of abdomen, 1 to 3 on each side, not more than 1 per side on any segment in available specimens. Tail-forming pore clusters limited to pair on 9th abdominal segment; each cluster consisting of 20 to 25 stellate pores. Body sparsely clothed with slender filamentous setae about 25 μ maximum length. Digitiform setae, about 30 μ maximum length, fairly numerous on head, a few on venter of prothorax, and 1 or 2 on venter of basal abdominal segments in one specimen.

Penial sheath (fig. 2, K) about 120 μ total length; median lobes represented by barely discernible humps; posterior portion tapering evenly to a rounded apex, about 9 or 10 μ wide at 9 μ before tip.

Legs of moderate size, hind femora about 165 μ long; clothed with digitiform setae about 27 μ maximum length, plus a very few slender filamentous setae of comparable length. Claw of hind tarsus about 30 μ long.

Abdominal sclerotization strongly developed, consisting of a series of broad transverse ventral patches, one on each of segments 5 to 9, plus smaller less strongly sclerotized patches on venter of segments 2 to 4; dorsum with similar patches on segments 7 to 9, a reduced or incomplete patch, consisting of incompletely separated anterior and posterior transverse patches, on dorsum of segment 6.

Based on 2 specimens: Summit, Poamoho Trail, Oahu, Jan. 1, 1959 (J. W. Beardsley), reared ex *Dicranopteris owhyhensis* Hooker.

Pedronia cibotii Beardsley

Pedronia cibotii Beardsley, 1957. PROC. HAW. ENT. SOC. 16(2):222, fig. 2

Male. Body length about 1.0 mm.; available specimens macropterous. Antennae 10-segmented, about 540 to 600 μ total length; 3rd segment about 72 μ long. Antennae clothed with slender digitiform setae about 34 μ maximum length, plus a few slender filamentous setae about 45 μ maximum length. Slightly thicker

specialized sensory setae, about 45 μ maximum length, present on 3 apical segments. Head with a weakly developed dorsomedial sclerite, and a well-defined dorsal midcranial ridge. Eyes small, dorsal pair each about 24 μ in diameter, ventral pair each about 27 μ in diameter.

Dermal discs mostly with 4 peripheral loculi, an occasional one with 3 or 5. One to 3 discs on each side of most abdominal segments 3 to 8, sometimes absent from 1 or both sides of 1 or 2 segments; 1 to 3 on each side of segment 2; apparently absent on thorax and head. Tail-forming pore clusters confined to pair on 9th abdominal segment, each cluster consisting of around 20 to 25 stellate pores. Body clothed with digitiform setae about 30 μ maximum length, plus slender filamentous setae mostly 18 μ long or less, a few longer filamentous setae up to about 36 μ in length along lateral margins of abdominal segments near dermal discs. Digitiform setae moderately numerous on head; usually 1 to 4 on venter of each segment of abdomen; 1 or 2 on dorsum of basal abdominal segment.

Penial sheath (fig. 2, L) about 120 μ total length; median lobes represented by a pair of very small humps; posterior portion tapering to a short, rounded apex, about 9 μ wide at 9 μ before tip.

Legs of moderate length, hind femora about 165 μ long; clothed with digitiform setae about 30 μ maximum length, plus a few slender filamentous setae about 24 μ maximum length. Claw of hind tarsus about 28 μ long.

Abdominal sclerotization consisting of a broad median transverse patch on dorsum of 9th segment, a pair of small weak transverse patches on venter of 9th segment; plus a pair of weak transverse patches, one each side of midline near posterior margin of dorsum of segment 2. Setae of abdomen, particularly those of the posterior segments, with narrow rings of sclerotization around their bases.

Based on 10 specimens: Mt. Tantalus, Oahu, June 20, 1959 (J. W. Beardsley), reared ex fronds of *Cibotium chamissoi* Kaulfuss.

Pedronia crypta Beardsley

Pedronia crypta Beardsley, 1957. PROC. HAW. ENT. SOC. 16(2):226, fig. 4.

Male. Over-all length about 1.0 mm.; available specimen macropterous. Antennae 10-segmented, short, about 450 μ total length; 3rd segment about 50 μ long. Antennae clothed with slender digitiform setae about 35 μ maximum length, plus a few slender filamentous setae about 45 μ maximum length. Thicker specialized sensory setae on 3 apical segments about 45 μ maximum length. Head with a moderately well-defined dorsomedial sclerite with a darker central midcranial ridge. Eyes small, dorsal pair each about 20 μ in diameter, ventral pair each about 24 μ in diameter.

Dermal discs mostly with 4 peripheral loculi, an occasional one with 5; 1 each side of most of abdominal segments 2 to 8, absent from one or both sides of 1 or 2 segments; 2 discs on one side of segment 4 in only available specimen; 1 or 2

discs on each side of prothorax. Tail-forming pore clusters limited to pair on 9th abdominal segment; each cluster consisting of 25 to 30 stellate pores. Body sparsely clothed with slender filamentous setae mostly about 27 μ or less in length, a few longer setae up to about 33 μ long on lateral margins of posterior abdominal segments. Around 25 digitiform setae about 30 μ maximum length on head, plus a few (only 3 in specimen at hand) on venter of abdomen.

Penial sheath[1] about 95 μ total length; median lobes represented by a pair of barely discernible humps; posterior portion evenly tapered to a rounded apex about 8 or 10 μ wide at 9 μ before tip.

Legs moderately short, hind femora about 140 μ long; clothed with digitiform setae about 30 μ maximum length, plus a few slender filamentous setae of comparable length. Claw of hind tarsus about 25 μ long.

Abdominal aclerotization consisting of a median transverse patch on dorsum of segment 9; similar, less distinct, and more irregular patches on dorsum of segments 7 and 8; a pair of patches on venter of segment 9, 1 on each side of midline near base of penial sheath. Setae of abdomen with narrow weak rings of sclerotization around their bases.

Based on 1 specimen: Kahalau Lookout, Kokee, Kauai, August 30, 1959 (J. W. Beardsley), reared ex *Dicranopteris owhyhensis* Hooker.

Pedronia hawaiiensis Ferris

Pedronia hawaiiensis Ferris, 1948. INS. HAWAII 5:168, fig. 97.

Male. Body length about 1.0 mm.; available specimens macropterous. Antennae 10-segmented, about 600 μ total length; 3rd segment about 80 μ long. Antennae clothed with digitiform setae about 36 μ maximum length, plus a few slender filamentous setae about 45 μ maximum length. Specialized sensory setae of 3 apical segments about 40 μ maximum length. Head with a moderately well-developed dorsomedial sclerite. Eyes small, dorsal pair each about 22 μ in diameter, ventral pair head about 26 μ in diameter.

Dermal discs mostly with 4 peripheral loculi, a few with 3 or 5; 1 each side of most abdominal segments 2 to 8, occasionally absent on 1 or both sides of 1 or more segments; apparently absent on head and thorax. Tail-forming pore clusters limited to pair on 9th abdominal segment; each cluster consisting of 30 to 35 stellate pores. Body sparsely clothed with slender filamentous setae mostly about 24 μ maximum length, a few on lateral margins of abdominal segments near dermal discs up to about 45 μ maximum length. Slender digitiform setae, about 24 μ maximum length, on head, venter of thorax, plus a very few sometimes on venter of abdomen (not more than 2 or 3 in available specimens).

Penial sheath (fig. 2, M) about 105 μ total length; median lobes represented by small humps; posterior portion tapering to a rounded apex about 10 μ wide at 9 μ before tip.

[1] The penial sheath of the male of this species has not been figured as it is imperfectly aligned in the only specimen available.

Legs moderately small, hind femora about 150 μ long; clothed with slender digitiform setae about 30 μ maximum length, plus a few slender filamentous setae of comparable length. Claw of hind tarsus about 28 μ long.

Abdominal sclerotization consisting of a broad transverse median patch on dorsum of segment 9; a pair of small patches on venter of segment 9, 1 on each side of midline. Setae of abdomen with narrow rings of sclerotization around their bases.

Based on 6 specimens: Aiea Loop Trail, Oahu, May, 1959 (J. W. Beardsley), reared ex *Dicranopteris linearis* (Burmeister) Underwood.

Males of this species are very close to those of *P. cibotii*. Although most of the specimens of the later species have slightly longer penial sheaths than *P. hawaiiensis*, there appears to be some overlap in the range of this character in the two species. For the present, I am unable to find any structural characters suitable for unequivocal separation of these 2 forms in the male sex.

Phenacoccus gossypii Townsend and Cockerell

Phenacoccus gossypii Townsend and Cockerell, 1898. Jour. New York Ent. Soc. 6(3):170.

Male. Body length about 1.4 mm.; available specimens macropterous. Antennae 10-segmented, about 1.2 mm. total length; 3rd segment about 150 μ long. Antennae clothed with slender digitiform setae about 45 μ maximum length, plus a few slender filamentous setae of comparable length. Specialized sensory hairs of 3 apical segments only slightly thicker than digitiform setae, about 60 μ maximum length. Dorsomedial sclerite of head not strongly developed. Midcranial ridge broad dorsally with irregular margins, not interrupted above juncture of the two lateral branches as in other species studies. Eyes large, very prominent, dorsal pair each about 57 μ in diameter, ventral pair each about 60 μ in diameter.

Dermal discs apparently all stellate, with 5 peripheral loculi; 1 to 4 on each side of abdominal segments 2 to 7, plus several (2 to 4) in a row across the dorsum of these segments; 1 or 2 on each side of anterior part of prothorax. Abdomen with a pair of tail-forming pore clusters on both segments 8 and 9. Clusters of 8th segment each with 35 to 40 stellate pores, those of 9th segment each with about 45 to 50 such pores. Body sparsely clothed with slender filamentous setae mostly 28 to 30 μ long, a few up to 45 μ long on lateral margins of posterior adbominal segments. Digitiform setae apparently confined to antennae and legs.

Penial sheath (fig. 2, N) about 105 to 110 μ long; without discernible median lobes; posterior portion tapering to a slender apex about 6 or 7 μ wide at 9 μ before tip; ventral portion of sheath largely membranous, not completely sclerotized as in other species studied (sclerotized areas indicated by stippling in figure). Extent of ventral slit not definitely discernible in the specimens available.

Legs relatively long, hind femora about 245 μ in length; clothed with slender digitiform setae about 30 μ in maximum length plus a few slender filamentous

setae of comparable length. Claw of hind tarsus about 40 μ long, without the small tooth on the inner surface characteristic of females of the genus.

Abdominal sclerotization consisting of a series of dorsal patches, a pair of which appear to lie on the anterior margin of abdominal segments 3 to 7, one on each side of the midline. Segments 5 to 7 each bearing in addition a narrow, interrupted, median, transverse patch near the posterior margin. Dorsum of segment 8 with a pair of irregular patches on each side of the midline. Sclerotization of venter of abdomen consisting of small patches around the bases of the setae.

Based on 2 specimens: 1, Foster Gardens, Honolulu, Oahu, July 7, 1937 (C. E. Pemberton), on leaf of *Erythrina caffra* Thunb.; 1, Honolulu, Oahu, Aug. 26, 1954 (J. W. Beardsley), on *Buddleia davidi* Franch.

Males of this species exhibit the most distinctive features of any studied.

Phylococcus oahuensis (Ehrhorn)

Cissococcus (?) *oahuensis* Ehrhorn, 1912. PROC. HAW. ENT. SOC. 2(4):149, pl.5.
Phylococcus oahuensis (Ehrhorn) Ehrhorn 1916. PROC. HAW. ENT. SOC. 3(3):236.

Male. Body length about 1.25 mm.; available specimens macropterous. Antennae 10-segmented, about 665 μ total length; 3rd segment about 80 μ long. Antennae clothed with slender digitiform setae about 36 μ maximum length, plus a few slender filamentous setae about 60 μ maximum length. Three apical segments with thicker specialized sensory hairs up to about 50 μ maximum length. Head with a prominent midcranial ridge dorsally; with a weakly developed dorsomedial sclerite. Eyes of moderate size, dorsal pair each about 32 μ in diameter, ventral pair each about 35 μ in diameter.

Dermal discs mostly with 4 peripheral loculi, an occasional one with 3 or 5; distributed on lateral margins of abdomen, 1 or 2 on each side of most of segments 3 to 8; sometimes absent on one or both sides of one or more segments; 3 to 5 on each side of segment 2; 2 or 3 on each side of prothorax. Tail-forming pore clusters confined to pair on 9th abdominal segment; each cluster composed of 40 to 50 stellate pores. Body sparsely clothed with slender filamentous setae about 33 μ maximum length. Digitiform setae confined to antennae, legs, and head; those of head about 30 μ maximum length.

Penial sheath (fig. 2, O) about 120 μ total length; without discernible median lobes; posterior extension evenly tapered to a rounded apex, 9 or 10 μ wide at 9 μ before tip. Posterior extension somewhat elongate, about one-third the total length of the sheath.

Legs of moderate length, hind femora about 200 μ long; clothed with slender digitiform setae about 33 μ maximum length, plus a very few slender filamentous setae of comparable length. Claw of hind tarsus about 30 μ long.

Abdominal sclerotization consisting of a broad median transverse patch on dorsum of segment 9; and a pair of small patches on venter of segment 9, one on each side near base of penial sheath.

Based on 2 entire and 4 fragmentary specimens removed from galls on leaves of hebarium specimens of *Urera glabra*; collected in Mts. near Koele, Lanai, June, 1913 (C. N. Forbes).

Planococcus citri (Risso)

Dorthesia citri Risso, 1813. HIST. NAT. DES ORANGES
Dactylopius citri (Risso) Signoret, 1875. ANN. ENT. SOC. FRANCE (5), vol. 5:312.
Pseudococcus citri (Risso) Fernald, 1903. CAT. COCCIDAE OF THE WORLD, p. 99.
Planococcus citri (Risso) Ferris, 1950. ATLAS OF SCALE INS. OF NO. AMERICA 5:165, fig. 63.

Male. Body length about 1.0 mm.; available specimens macropterous. Antennae 10-segmented, 610 to 620 μ total length; 3rd segment about 75 μ long. Antennae clothed with digitiform setae about 27 μ maximum length, plus slender filamentous setae about 45 μ maximum length. Three apical segments with thicker specialized sensory hairs about 45 μ maximum length: Head with a well-defined dorsomedial sclerite; without a discernible dorsal midcranial ridge. Eyes of moderate size, dorsal pair each about 33 μ in diameter, ventral pair each about 36 μ in diameter.

Dermal discs mostly with 4 peripheral loculi, an occasional one with 3 or 5; distributed on lateral margins of abdomen, 1 to 5 on each side of each of segments 3 to 8, 8 to 16 on each side of segment 2; 4 to 6 on each side of prothorax; 1 or 2 on each side of anterior portion of head between antennae. Tail-forming pore clusters limited to pair on 9th abdominal segment; each cluster consisting of about 50 to 60 stellate pores. Body sparsely clothed with slender filamentous setae about 27 μ maximum length. Digitiform setae confined to antennae and legs.

Penial sheath (fig. 3, A) about 105 μ total length; with a pair of small but readily discernible median lobes; posterior extension slender, about 6 μ wide at 9 μ before tip, apex rounded.

Legs of moderate length, hind femora about 185 μ long; clothed with digitiform setae about 27 μ maximum length, plus a few slender filamentous setae about the same length. Claw of hind tarsus about 40 μ long.

Abdominal sclerotization consisting of a broad median transverse patch on dorsum of 9th segment; a pair of small patches on venter of 9th segment, one on each side near base of penial sheath; a pair of small transverse patches, one on each side of midline, on posterior margin of dorsum of segment 2; a pair of smaller patches in a similar position of dorsum of segment 3. Setae of posterior abdominal segments, particularly those of venter, with very narrow rings of weak sclerotization about their bases.

Based on about 20 specimens: Honolulu, Oahu, June 1959 (J. W. Beardsley), reared ex laboratory culture on potato sprouts.

Pseudococcus antricolens Ferris

Pseudococcus antricolens Ferris, 1948 INS. HAWAII 5:181, fig. 102.

Male. Body length about 1.3 mm.; available specimens macropterous. Antennae 10-segmented, about 640 μ total length; 3rd segment about 90 μ long. Antennae clothed with slender digitiform setae about 33 μ maximum length, plus a few slender filamentous setae about 30 μ maximum length. Thicker specialized sensory setae of 3 apical segments about 45 μ maximum length. Head with a broad dorsomedial sclerite. Eyes moderately large, ventral pair each about 39 μ in diameter, ventral pair each about 42 μ in diameter.

Dermal discs mostly with 4 peripheral loculi, an occasional one with 3 or 5; distributed along lateral margins of abdomen, 1 or 2 on each side of all or most of abdominal segments 3 to 7, 2 or 3 on each side of segment 8, 3 to 6 on each side of prothorax; 3 or 4 on each side of midcranial suture on front part of head between antennae. Tail-forming pore clusters restricted to pair on 9th segment of abdomen; each cluster composed of 50 to 60 stellate pores. Body clothed with digitiform setae about 28 μ maximum length, plus slender filamentous setae mostly 24 μ long or less; digitiform setae predominating on venter of abdomen, relatively few on dorsum of abdomen.

Legs of moderate length, hind femora about 200 μ long; clothed with digitiform setae about 33 μ maximum length, plus a very few slender filamentous setae. Claw of hind tarsus about 34 μ long.

Penial sheath (fig. 3, B) about 160 μ total length; with a well-developed pair of median lobes. Posterior portion with tip nearly truncate, slightly expanded, about 27 or 28 μ wide across expanded portion.

Abdominal sclerotization consisting of a large median transverse patch on dorsum of 9th segment; a pair of very small patches on venter of segment 9, one on each side near base of penial sheath; a small, interrupted, transverse patch near the posterior margin of dorsum of segment 8; a pair of small transverse patches, one on each side of the mid-line, along posterior margin of dorsum of segments 2 and 3. Setae of posterior abdominal segments with very narrow rings of sclerotization around their bases.

Based on 7 specimens: Aiea Loop Trail, Oahu, June, 1959 (J. W. Beardsley), reared from leaf galls ex *Santalum freycinetianum* Gaud.

There appears to be a complex of species or subspecies related to *Pseudococcus gallicola* Ehrhorn and *P. antricolens* Ferris which occur on the various species of *Santalum* in the Hawaiian Islands. These will require careful collecting and study before their relationships are clear. I have collected two forms on Oahu, and one each on Kauai and Hawaii, but none of these exactly fit Ferris' concept of either to the two described species mentioned above. The females associated with males described above seem to be quite close to *P. antricolens* except that the antennae are 8-segmented in all but one specimen, and that has one 8- and one 7-segmented antenna. *P. antricolens* was described as having 7-segmented

antennae. Although Ferris placed considerable emphasis on this character in separating *P. antricolens* and *P. gallicola*, it has been my experience that in endemic Hawaiian mealybugs the number of antennal segments frequently varies between 7 and 8 segments in specimens from a single population, and sometimes even on opposite sides of the same specimen.

Pseudococcus citriculus Green

Pseudococcus citriculus Green, 1922. COCCIDAE OF CEYLON 5:377, pl. 154.

Male. Body length about 1.2 mm.; available specimens macropterous. Antennae clothed with rather slender digitiform setae about 30 μ maximum length, plus a few slender filamentous setae about 33 μ maximum length. Thicker specialized sensory hairs, 50 to 60 μ long, present on three apical segments. Head with a sharply defined midcranial suture dorsally, without a discernible dorsomedial sclerite. Eyes of moderate size, dorsal pair each about 34 μ in diameter, ventral pair each about 38 μ in diameter.

Dermal discs mostly with 4 peripheral loculi, an occasional one with 5; distributed on lateral margins of abdominal segments, 1 or 2 on each side of segments 3 to 7, 3 or 4 on each side of segments 2 and 8; 3 or 4 discs on each side of prothorax; usually 2 on anterior part of head between antennae. Tail-forming pore clusters confined to pair on 9th abdominal segment; each cluster composed of around 40 to 50 stellate pores. Body clothed with digitiform setae about 29 μ maximum length, plus slender filamentous setae 39 μ maximum length.

Penial sheath (fig. 3, C) about 200 μ total length; without discrenible median lobes; tapering evenly to a rounded apex, about 22 μ wide at 9 μ before tip.

Legs moderately large, hind femora about 180 μ long; clothed with digitiform setae up to about 30 μ long, plus a very few slender filamentous setae, about 39 μ maximum length (on hind femora). Claw of hind tarsus about 36 μ long.

Abdominal sclerotization consisting only of a transverse patch on the dorsum of the 9th segment.

Based on 2 specimens: Manoa Valley, Oahu, May 1, 1945 (E. C. Zimmerman), on Pomelo.

Pseudococcus dorsispinosus Beardsley

Pseudococcus dorsispinosus Beardsley, 1959. PROC. HAW. ENT. SOC. 17(1):40, fig. 1.

Male. Body length about 1.2 mm.; available specimens macropterous. Antennae 10-segmented, about 640 μ total length; 3rd segment about 90 μ long. Antennae clothed with slender digitiform setae about 30 μ maximum length, plus a few slender filamentous setae about 40 μ maximum length. Thicker specialized sensory setae of 3 apical segments about 48 μ maximum length. Midcranial ridge becoming broader dorsally, its margins irregular, appearing like a very narrow dorsomedial sclerite, widening somewhat toward its posterior end.

Eyes moderately large, dorsal pair each about 36 μ in diameter, ventral pair each about 45 μ in diameter.

Dermal discs mostly with 4 peripheral loculi, an occasional one with 3 or 5; distributed along lateral margins of abdomen, some or all of segments 3 to 7 with 1 such disc on each side, segments 2 and 8 each usually with 2 discs on each side; 4 or 5 discs on each side of prothorax; 2 or 3 discs on each side of anterior part of head between antennae. Tail-forming pore clusters restricted to pair on 9th abdominal segment; each cluster with 30 to 40 stellate pores. Body clothed with both digitiform and slender filamentous setae, both types about 27 μ maximum length; digitiform setae predominating on head and venter of abdomen, less numerous on dorsum of abdomen.

Legs of moderate length, hind femora about 195 μ long; clothed with digitiform setae about 39 μ maximum length, plus a few slender setae about 50 μ maximum length. Claw of hind tarsus about 42 μ long.

Penial sheath (fig. 3, D) about 148 μ total length; with a pair of well developed median lobes; posterior portion with the tip slightly rounded, noticeably expanded and relatively very broad, about 35 or 36 μ wide across expanded part of tip.

Abdominal sclerotization consisting of a broad transverse patch on dorsum of segment 9; two small patches on venter of segment 9, one on each side of the midline; a small median transverse patch near posterior margin, and a pair of small transverse patches one on either side of the midline on the anterior margin of the dorsum of segment 8; a small interrupted median transverse patch on dorsum of segment 7; a pair of small transverse patches one on each side on the posterior margin of the dorsum on segments 2, 3, and 4. Bases of abdominal setae surrounded by well-defined rings of sclerotization, particularly on the posterior segments of the venter.

Based on 3 specimens: Mt. Tantalus, Oahu, July 4, 1956 (J. W. Beardsley), on leaves of *Pipturus*.

Pseudococcus floriger Ferris

Pseudococcus floriger Ferris, 1948. Ins. Hawaii 5:212, fig. 120.

Male. Body length about 1.0 mm.; available specimens macropterous. Antennae 10-segmented; relatively short, about 400 to 425 μ over-all length; 3rd segment about 54 μ long. Antennae clothed with both digitiform and slender filamentous setae, the former predominating. Digitiform setae about 24 μ maximum length, slender setae about 33 μ maximum length. Thicker specialized sensory setae about 42 μ maximum length present on last 3 segments. Midcranial suture of head broadened dorsally, its margins irregular, appearing like a very narrow dorsomedial sclerite. Eyes small; dorsal pair each about 23 μ in diameter, ventral pair each about 25 μ in diameter.

Dermal discs mostly with 4 peripheral loculi; distributed along lateral margins of abdomen, 1 or 2 on each side of majority of abdominal segments 3 to 8;

3 or 4 on each side of abdominal segment 2; about 4 to 6 on each side of the prothorax; and 1 or 2 on anterior part of head between antennae. Tail-forming pore clusters restricted to pair on 9th abdominal segment; each cluster composed of 35 to 40 stellate pores. Body sparsely clothed with slender filamentous setae mostly 24 to 30 μ long. Digitiform setae restricted to legs, antennae, and head; those of head about 22 μ maximum length.

Penial sheath (fig. 3, E) about 135 μ over-all length; with a pair of well-developed median lobes; posterior extension with the tip nearly truncate, slightly expanded, about 10 μ wide.

Legs fairly small, hind femora about 135 to 140 μ long; clothed with digitiform and slender setae, both types about 24 μ maximum length on hind femora. Claw of hind tarsus about 26 μ long.

Abdominal sclerotization consisting of a broad transverse patch on dorsum of 9th segment; two small patches on venter of 9th segment, one on each side near base of penial sheath; a pair of narrow transverse patches along the anterior margin of dorsum of segment 8, one on each side of the midline. Setae of abdominal segments, particularly the posterior ones, with bases surrounded by well-developed narrow sclerotized rings or small patches.

Based on 5 specimens: Wailupe Valley, Oahu, December 26, 1956 (J. W. Beardsley), in crowns of *Dracaena aurea* Mann.

Pseudococcus lycopodii Beardsley

Pseudococcus lycopodii Beardsley, 1959. PROC. HAW. ENT. SOC. 17(1):44, fig. 2.

Male. Body length about 1.2 mm.; available specimens macropterous. Antennae 10-segmented, about 730 μ total length; 3rd segment about 105 μ long. Antennae clothed with relatively very slender digitiform setae about 45 μ maximum length, plus a few more slender filamentous setae about 45 μ maximum length. Thicker specialized sensory setae, 40 to 60 μ long, present on 3 apical segments. Head with a poorly defined dorsomedial sclerite, its lateral margins irregular, but bisected by a well-defined midcranial ridge. Eyes of moderate size, dorsal pair each about 32 μ in diameter, ventral pair each about 36 μ in diameter.

Dermal discs mostly with 4 peripheral loculi, an occasional one with 3 or 5; distributed along lateral margins of abdomen, 1 on each side of most of segments 3 to 7, usually 2 on each side of segment 8, and 4 to 6 on each side of segment 2; 4 to 6 on each side or prothorax; 2 on anterior part of head between antennae. Tail-forming pore clusters limited to pair on 9th abdominal segment; each cluster composed of 50 to 60 stellate pores. Body clothed with digitiform setae about 36 μ maximum length, and slender filamentous setae about 30 μ maximum length. Digitiform setae about as numerous on dorsum of abdomen as on the venter.

Penial sheath (fig. 3, G) about 145 μ total length; with a well-developed pair of median lobes; posterior extension with the tip nearly truncate, slightly expanded, about 24 or 25 μ wide across expanded portion.

Legs moderately large, hind femora about 195 μ long; clothed with long digitiform setae about 45 μ maximum length on hind femora, plus a few slender filamentous setae about 30 μ maximum length. Claw of hind tarsus about 37 μ long.

Abdominal sclerotization consisting of a median transverse patch on dorsum of 9th segment; 2 small transverse patches on venter of segment 9, one on each side of the midline near base of penial sheath; a pair of small transverse patches, one on each side of the midline, on posterior margin of dorsum of segments 2 and 3.

Based on 15 specimens: Summit, Poamoho Trail, Oahu, January 1, 1959 (J. W. Beardsley), bred ex *Lycopodium cernuum* L.

Laminicoccus giffardi (Ehrhorn)

Tylococcus giffardi Ehrhorn, 1916. PROC. HAW. ENT. SOC. 3(3):243.
Pseudococcus giffardi (Ehrhorn) Zimmerman, 1948. INS. HAWAII 5:219, fig. 122.
Laminicoccus giffardi (Ehrhorn) Williams, 1960. BULL. BRITISH. MUS. (NAT. HIST) ENT. 8(10):402.

Male. Body length about 1.1 mm.; available specimens macropterous. Antennae 10-segmented, short, about 450 to 470 μ total length; 3rd segment about 65 μ long. Antennae clothed with short digitiform setae about 18 μ maximum length, plus longer slender filamentous setae about 30 μ maximum length. A specialized sensory hair up to about 36 μ long, as thick or thicker than digitiform setae, on each of 3 apical segments. Head with sharply defined midcranial ridge dorsally; without a well-defined dorsomedial sclerite. Eyes small, dorsal pair each about 24 μ in diameter, ventral pair each about 27 μ in diameter.

Dermal discs mostly with 4 peripheral loculi, an occasional one with 3 or 5; distributed along lateral margins of abdomen, 3 to 5 discs on each side of segments 3 to 7; 4 to 6 each side of segment 8; 12 to 16 each side of segment 2; 15 to 20 each side of prothorax; 1 to 3 on each side of anterior part of head between antennae. Tail-forming pore clusters confined to 9th abdominal segment; each cluster composed of 35 to 45 stellate pores. Body clothed with moderately numerous slender filamentous setae mostly 20 to 33 μ long, some of those on head considerably longer, up to about 45 μ long. A relatively very few digitiform setae, about 18 μ long, present on head and abdomen, most numerous on venter of head, 1 to 4 on dorsum of each of several abdominal segments, a comparable number on venter.

Penial sheath (fig. 3, F) about 140 μ total length; without discernible median lobes; posterior portion tapering to a rounded apex about 14 μ wide at 9 μ before tip.

Legs of moderate length, hind femora about 175 to 180 μ long; clothed with slender filamentous setae about 35 μ maximum length, plus a few digitiform setae about 18 μ maximum length. Claw of hind tarsus about 30 μ long.

Abdominal sclerotization consisting of a median transverse patch on dorsum of segment 9; a median transverse patch near anterior margin of venter of segment 9; a median transverse patch along anterior margin of dorsum of segment 8; a similar but interrupted patch on dorsum of segment 7; small median transverse patches on anterior margin of venter of segments 7 and 8. Setae of posterior abdominal segments, particularly those located near the midline on both dorsum and venter, with conspicuous rings or small patches of sclerotization about their bases.

Based on 6 specimens: Aina Haina, Oahu, March, 1959, (J. W. Beardsley), reared ex *Pandanus* crown.

Pseudococcus maritimus (Ehrhorn)

Dactylopius maritimus Ehrhorn, 1900. CANAD. ENT. 32(10):316, pl. 7, fig. 7.
Pseudococcus maritimus (Ehrhorn) Fernald, 1903. CAT. OF THE COCCIDAE OF THE WORLD, p. 106.

Male. Body length about 1.25 mm., available specimens macropterous. Antennae 10-segmented, about 640 μ total length; 3rd segment about 90 μ long. Antennae clothed with digitiform setae about 25 μ maximum length, plus a few slender filamentous setae about 33 μ maximum length. Thicker specialized sensory setae about 36 μ maximum length on 3 apical segments. Head with a well-developed midcranial suture; dorsomedial sclerite present but weakly developed. Eyes of moderate size, dorsal pair each about 33 μ in diameter, ventral pair each about 39 μ in diameter.

Dermal discs mostly with 4 peripheral loculi, an occasional one with 3 or 5; distributed along lateral margins of abdomen, 1 to 3 on each side of abdominal segments 3 to 7, 3 or 4 on each side of segment 8, 6 to 10 on each side of segment 2; 6 to 10 on each side of prothorax; about 2 on each side of anterior portion of head between antennae. Tail-forming pore clusters confined to 9th abdominal segment; each cluster composed of 40 to 50 stellate pores. Body clothed with digitiform setae about 21 μ maximum length, plus slender filamentous setae about 25 μ maximum length.

Penial sheath (fig. 3, H) about 175 μ total length; without discernible median lobes; posterior portion slightly expanded before tip, about 30 μ wide across expanded portion.

Legs moderately long, hind femora about 205 μ in length; clothed with digitiform setae about 25 μ maximum length, plus a very few slender filamentous setae about 24 μ maximum length. Claw of hind tarsus about 38 μ long.

Abdominal sclerotization consisting of a broad transverse patch on dorsum of 9th segment; a pair of small irregularly shaped patches on venter of segment 9, one on each side near base of penial sheath; an irregular median transverse patch near posterior margin of dorsum of segment 8; a pair of small transverse patches, one on each side of the midline, on anterior margin of dorsum of segments 3 to 8,

decreasing in size posteriorly on segments 4, 5, and 6, increasing slightly on segments 7 and 8. Bases of abdominal setae, particularly those of the posterior segments, surrounded by narrow rings of sclerotization. Dorsal ostioles quite well developed.

Based on 2 specimens: Manoa Valley, Oahu, May 24, 1939 (O. H. Swezey), on *Crossandra*.

Pseudococcus montanus Ehrhorn

Pseudococcus montanus Ehrhorn, 1916. PROC. HAW. ENT. SOC. 3(3):242.

Male. Body length about 1.1 mm.; available specimens macropterous. Antennae 10-segmented, about 450 to 550 μ total length; 3rd segment about 65 μ long. Antennae clothed with slender digitiform setae about 24 μ maximum length, plus slender filamentous setae mostly 30 to 45 μ long. Thicker specialized sensory hairs on 3 apical segments about 50 μ maximum length. Head with dorsomedial sclerite moderately well-developed, its lateral edges irregular. Eyes of moderate size, dorsal pair each about 30 μ in diameter, ventral pair each about 36 μ in diameter.

Dermal discs mostly with 4 peripheral loculi, an occasional one with 3 or 5; distributed along lateral margins of abdomen, 1 to 4 on each side of abdominal segments 3 to 7, 2 to 4 on each side of segment 8, 6 to 12 on each side of segment 2; 8 to 10 on each side of prothorax, 1 or 2 on each side of midcranial ridge on anterior portion of head between antennae. Tail-forming pore clusters confined to pair on 9th abdominal segment; each cluster consisting of 30 to 40 stellate pores. Body sparsely colthed with digitiform and slender setae, the former much less numerous than the latter. Digitiform setae about 24 μ maximum length, fairly numerous on head, relatively few on abdomen, there confined almost entirely to venter, 2 to 4 on venter of most segments; slender setae mostly 27 μ long or less, a few longer ones associated with groups of dermal discs on lateral margins of abdominal segments, particularly on posterior segments, these up to about 45 μ long on 7th and 8th segments.

Penial sheath (fig. 3, I) about 135 μ long; median lobes wanting or represented by a pair of barely discernible humps; posterior portion tapering evenly to a bluntly rounded apex about 24 μ wide at 9 μ before tip.

Legs of moderate length, hind femora about 185 μ long; clothed with digitiform setae about 27 μ maximum length, plus slender filamentous setae about 30 μ maximum length. Claw of hind tarsus about 37 μ long.

Abdominal sclerotization consisting of a broad median transverse patch on dorsum of 9th segment; a pair of small patches on venter of 9th segment, one on each side near base of penial sheath; an interrupted median transverse band near the posterior margin of the dorsum of segment 8; a pair of small transverse bands on anterior margin of dorsum of segment 8, one on each side of the midline; a pair of transverse patches on the anterior margin of the dorsum of segment 3,

one on each side of the midline; sometimes a smaller pair of patches in this position on segment 4. Rings or small patches of sclerotization about some setae on posterior abdominal segments.

Based on 8 specimens: Mt. Tantalus, Oahu, June 20, 1959 (J. W. Beardsley), reared ex *Freycinetia arborea* Guadichaud.

Palmicola palmarum (Ehrhorn)

Ripersia palmarum Ehrhorn, 1916. PROC. HAW. ENT. SOC. 3(3):245.
Pseudococcus palmarum (Ehrhorn) Zimmerman, 1948. INS. HAWAII 5:235, fig. 130.
Palmicola palmarum (Ehrhorn) Williams, 1960. BULL. BRITISH MUS. (NAT. HIST.) ENT. 8(10):415.

Macropterous male. Body length about 1.0 mm. Antennae 9-segmented; about 300 μ total length; 3rd segment about 40 μ long. Antennae clothed with short digitiform setae about 15 μ maximum length, plus longer slender filamentous setae about 30 μ maximum length. Three apical segments with thicker specialized sensory setae about 38 μ maximum length. Head without a discernible dorsomedial sclerite or a dorsal midcranial ridge. Eyes small, dorsal pair each about 27 μ in diameter, ventral pair each about 30 μ in diameter.

Dermal discs mostly with 4 peripheral loculi, a few with 5; distributed along lateral margins of abdomen, 2 to 4 on each side of segments 3 to 7, 3 to 5 on each side of segment 8, 4 to 8 on each side of segemnt 2; 6 to 8 on each side of prothorax; 6 to 10 or so on anterior part of head between antennae. Tail-forming pore clusters confined to 9th abdominal segment; each cluster consisting of 35 to 40 stellate pores. Body clothed with numerous short digitiform setae about 15 μ maximum length; plus a few slender filamentous setae mostly 15 to 25 μ long. A few longer slender setae, up to about 36 μ maximum length, associated with dermal discs on lateral margins of posterior abdominal segments.

Penial sheath (fig. 3, J) about 117 μ total length; without discernible median lobes; posterior portion tapering to a relatively fine point, about 7 or 8 μ wide at 9 μ before tip.

Legs relatively short, hind femora about 135 to 150 μ long; clothed with short digitiform setae about 15 μ maximum length, plus a few slender filamentous setae about 27 μ maximum length. Claw of hind tarsus about 30 to 32 μ long.

Abdominal sclerotization consisting of a transverse patch on dorsum of 9th segment; a pair of small patches on venter of 9th segment, one on each side near base of penial sheath. Dorsum of segment 8 with a transverse area of weak sclerotization along anterior margin, and an interrupted transverse patch near posterior margin.

Brachypterous male. Similar to macropterous male except for following: wings reduced, non-functional, consisting of pads about 60 μ in length; mesothoracic sclerites smaller. Antennae 8-segmented, about 300 μ or less total length. Eyes

usually smaller than macropterous males, dorsal pair each about 21 μ in diameter, ventral pair each about 24 μ in diameter. Slender filamentous setae of abdomen longer than in macropterous males, up to 30 μ long on anterior segments, about 45 μ maximum length on lateral margins of posterior segments.

Based on 10 specimens (2 macropterous and 8 brachypterous): Honolulu, Oahu, March, 1959 (J. W. Beardsley), reared ex young leaves of MacArthur palm, *Actinophloeus macarthuri* (Wendl.) Becc..

Pseudococcus straussiae Ehrhorn

Pseudococcus straussiae Ehrhorn, 1916. PROC. HAW. ENT. SOC. 3(3):239.

Male. Body length about 1.2 mm.; available specimens macropterous. Antennae 10-segmented, about 690 μ total length; 3rd segment about 90 μ long. Antennae clothed with slender digitiform setae about 36 μ maximum length, plus a few slender filamentous setae about 70 μ maximum length. Three apical segments with thicker specialized sensory setae about 65 μ maximum length. Head with a well-defined midcranial ridge dorsally; without a conspicuously developed dorsomedial sclerite. Eyes moderately large, dorsal pair each about 36 μ in diameter, ventral pair each about 45 μ in diameter.

Dermal discs very few, those discernible with 4 peripheral loculi; most specimens with but 1 or 2 discs on each side of the abdomen, some individuals apparently without discs. Tail-forming pore clusters limited to pair on 9th abdominal segment; each cluster with about 60 stellate pores. Body sparsely clothed with long slender filamentous setae about 50 μ maximum length. Digitiform setae confined to antennae and legs plus a few, about 30 μ long, on venter of head.

Penial sheath (fig. 3, K) about 135 μ total length; without discernible median lobes; posterior extension tapering to a fine acute point about 6 or 7 μ wide at 9 μ before tip.

Legs moderately long, hind femora about 210 μ total length, clothed with slender filamentous setae about 50 μ maximum length plus a few slender digitiform setae about 33 μ maximum length. Claw of hind tarsus about 45 μ long.

Abdominal sclerotization consisting of a broad transverse patch on dorsum of segment 9; a pair of patches on venter of segment 9, one on each side near base of penial sheath; a pair of small transverse patches near anterior margin of dorsum of segment 8, one on each side of the midline; similar pairs of small transverse patches on anterior margins on dorsum of segments 3 and 4. Setae of posterior abdominal segments with rings or small patches of sclerotization about their bases.

Based on 14 specimens: 8, Mt. Tantalus, Oahu, Feb. 28, 1958 (J. W. Beardsley), reared ex *Straussia* leaves; 6, Waimano Valley, Oahu, Sept. 28, 1958 (J. W. Beardsley), reared ex *Straussia* leaves.

Nesococcus pipturi Ehrhorn

Nesococcus pipturi Ehrhorn, 1916. PROC. HAW. ENT. SOC. 3(3):246.

Male. Body length about 1.1 mm.; available specimens macropterous. Antennae 10-segmented, about 600 μ total length; 3rd segment about 80 μ long. Antennae clothed with slender digitiform setae about 36 μ maximum length, plus a very few slender filamentous setae about 45 μ maximum length. Three apical segments with thicker specialized sensory setae about 50 μ maximum length. Head with a very poorly developed dorsomedial sclerite; with a well-defined midcranial ridge dorsally. Eyes of moderate size, dorsal pair each about 33 μ in diameter, ventral pair each about 36 μ in diameter.

Dermal discs mostly with 4 peripheral loculi, an occasional one with 3 or 5; distributed along lateral margins of abdominal segments, 1 to 3 on each side of segments 3 to 8; 5 to 7 on each side of segment 2; 4 or 5 on each side of prothorax; 2 or 3 each side of anterior part of head between antennae. Tail-forming pore clusters confined to pair on 9th abdominal segment; each cluster consisting of 35 to 45 stellate pores. Body sparsely clothed with fine filamentous setae about 33 μ maximum length; plus a few digitiform setae about 27 μ maximum length distributed on head, venter of thorax, and 2 to 4 per segment on venter of most abdominal segments. Digitiform setae apparently absent on dorsum of abdomen.

Penial sheath (fig. 2, H) about 90 μ total length; without discernible median lobes; posterior portion tapering evenly to a rounded apex, about 10 or 11 μ wade at 9 μ before tip.

Legs of moderate length, hind femora about 190 μ long; clothed with slender digitiform setae about 30 μ maximum length, plus a very few slender filamentous setae of comparable length. Claw of hind tarsus about 42 μ long.

Abdominal sclerotization consisting of a median transverse patch on dorsum of segment 9; a pair of small weak transverse patches on venter of segment 9, one on each side of midline; sometimes a weak narrow transverse median patch near posterior margin of dorsum of segment 8; a pair of small transverse patches on posterior margin of dorsum of segment 2, one on each side of the midline.

Based on 14 specimens: Upper Niu Valley, Oahu, May 2, 1959 (J. W. Beardsley), reared from leaves of *Pipturus*.

Nipaecoccus nipae (Maskell)

Dactylopius nipae Maskell, 1892. TRANS. NEW ZEALAND INSTITUTE 25:232, pl. 15, figs. 12–15.

Pseudococcus nipae (Maskell) Fernald, 1903. CAT. OF THE COCCIDAE OF THE WORLD, p. 107.

Nipaecoccus nipae (Maskell) Ferris, 1950. ATLAS OF SCALE INS. OF NO. AMERICA 5:109, fig. 41.

Male. Small, body length 0.94 mm.; available specimens macropterous. Antennae 10-segmented, about 550 μ long; 3rd segment 60 μ long. Antennal setae mostly long and relatively slender, digitiform type not clearly differentiated although tips of some setae are less filamentous than others; mostly about 30 to 34 μ long. Apical segment with a pair of somewhat thicker specialized sensory hairs. Dorsum of head with a well-defined midcranial suture; without a noticeably developed dorsomedial sclerite. Eyes of moderate size, dorsal pair each about 27 μ in diameter, ventral pair each about 33 μ in diameter.

Dermal discs each about 6 μ outside diameter, with 6 or 7 peripheral loculi; distributed in groups of 6 to 8 on each side of abdominal segments 3 to 8; 10 or 12 on each side of segment 2; 10 or 12 on each anterio-lateral margin of prothorax; 2 discs on anterior part of head between antennae. Tail-forming pore clusters limited to pair on 9th abdominal segment; each cluster consisting of about 50 to 60 pores of the same type as dermal discs on anterior portions of the body, not stellate. Body sparsely clothed with slender filamentous setae mostly 16 to 20 μ long; digitiform setae absent.

Penial sheath (fig. 2, I) about 84 μ long; median lobes represented by a pair of barely discernible humps; posterior extension short, slender, about 6 μ wide at 9 μ before tip.

Legs moderately small, hind femora about 150 μ long. Setae of legs similar to those of antennae, about 27 μ maximum length. Tarsal claws relatively long, those of hind tarsi about 42 μ in length.

Abdominal sclerotization consisting only of a transverse median patch on dorsum of 9th segment.

Based on a single specimen: Kilauea, Hawaii, Aug. 4, 1946 (E. C. Zimmerman). A second specimen, in poor condition, mounted from material from Waialua, Oahu, March 12, 1938. (O. H. Swezey) on palm, differs in certain minor respects from the Kilauea specimen (e.g.: tarsal claws noticeably smaller, dermal discs much fewer in number). The latter specimen is from material of the yellow form of *N. nipae* (=*N. pseudonipae* of authors; see Ferris, 1948). It is hoped that in the future additional material of both the yellow (*pseudonipae*) and white (*nipae*) forms will become available for study in order to determine if there are consistent morphological differences between males of the two forms.

Nipaecoccus vastator (Maskell)

Dactylopius vastator Maskell, 1895. TRANS. NEW ZEALAND INSTITUTE 27:65, pl. 6, figs. 12–16.
Pseudococcus vastator (Maskell) Kirkaldy, 1902. FAUNA HAWAIIENSIS 3(2):103.
Nipaecoccus vastator (Maskell) Ferris, 1950. ATLAS OF SCALE INS. OF NO. AMERICA 5:103.

Male. Body length about 1.3 mm.; available specimens macropterous. Antennae 10-segmented, 975 to 1,000 μ long; 3rd segment about 100 μ long. Antennae

clothed with many digitiform setae 36 to 40 μ long, interspersed with a few slender filamentous setae of equal length or slightly shorter. Apical segment with 2 or 3 slightly thicker specialized sensory hairs near its tip, these not noticeably longer than digitiform setae. Head with a narrow dorsomedial sclerite. Dorsal and ventral eyes very large, subequal in size, each about 62 μ in diameter.

Dermal discs mostly with 5 or 6 peripheral loculi, an occasional one with 4; distributed in groups of from 2 to 5, one group on each side of abdominal segments 2 to 8, plus a few (usually 2 to 4) distributed across venter of each of most abdominal segments. One or 2 discs behind each spiracle; 2 or 3 at each side of anterolateral portion of prothorax; and usually two on anterior part of head between antennae. Tail-forming pore clusters restricted to ninth abdominal segment; each cluster large, containing around 100 stellate pores. The pair of very long hairs of each cluster set in a crater-like depression lined with closely-packed stellate pores which appear somewhat smaller than other pores in the cluster. Body sparsely clothed with fine slender setae mostly 20 to 30 μ long; a transverse row of 3 or 4 longer setae (up to about 45 μ in length) on the lateral margins of each abdominal segment behind the group of dermal discs. Digitiform setae restricted to antennae.

Penial sheath (fig. 2, J) about 125 μ over-all length; median lobes represented by a pair of very small protuberances; apical extension short, slender, tapering, about 7 μ wide at 9 μ before tip.

Legs moderately large, hind femora about 210 μ long; clothed with slender setae about 36 μ maximum length on hind femora. Tarsal claws long, those of hind legs about 42 μ in length.

Abdominal sclerotization consisting of a broad transverse patch on dorsum of 9th segment; two patches on venter of 9th segment, one on each side near base of penial sheath; and a pair of small transverse patches on posterior margin of dorsum of segment 2.

Based on 3 specimens: near Koko Head, Oahu, May 19, 1958 (J. W. Beardsley), on *Gossyparium tomentosum* Nutt.

Saccharicoccus sacchari (Cockerell)

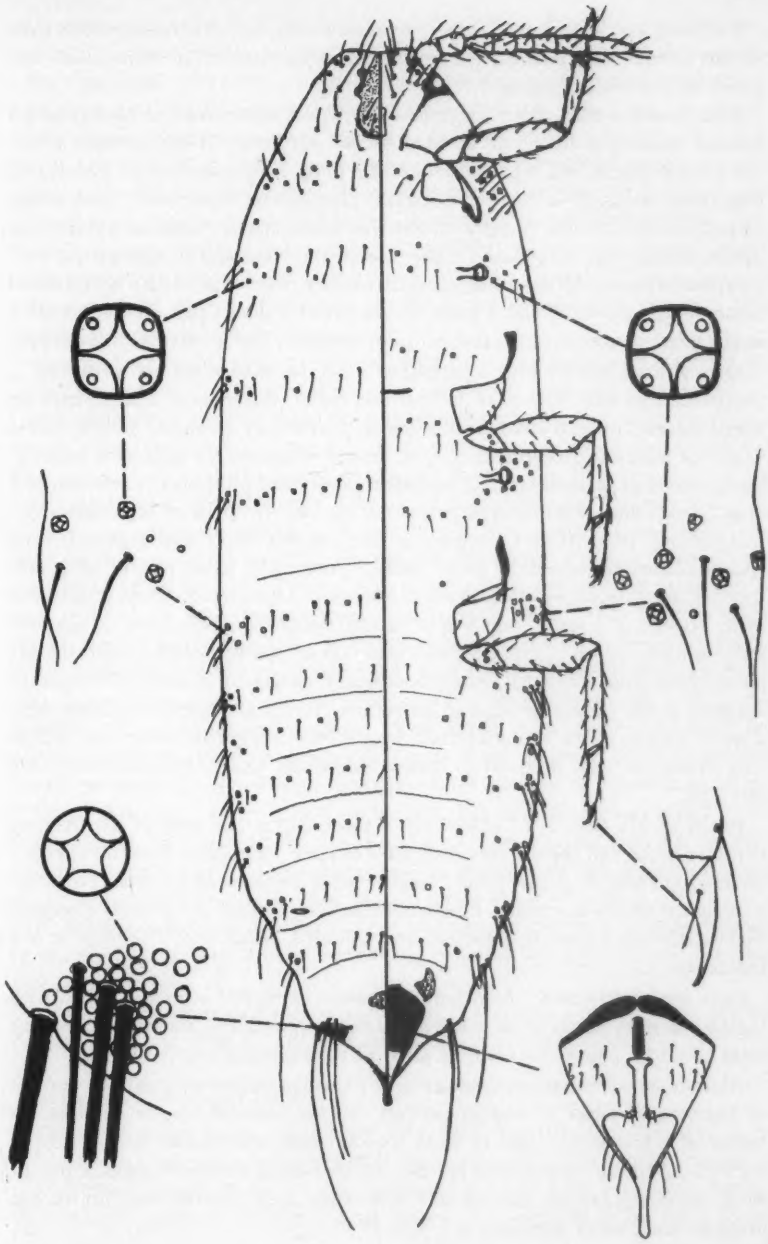
Dactylopius sacchari Cockerell, 1895. JOUR. TRINIDAD FIELD NATURALIST'S CLUB 2:195.

Pseudococcus sacchari (Cockerell) Fernald, 1903. CAT. OF COCCIDAE OF THE WORLD, p. 109.

Trionymus sacchari (Cockerell) Fullaway, 1923. PROC. HAW. ENT. SOC. 5:308.

Saccharicoccus sacchari (Cockerell) Ferris, 1950. ATLAS OF SCALE INS. OF NO. AMERICA 5:217, fig. 81.

FIGURE 4. *Saccharicoccus sacchari* (Cockerell), adult apterous male; dorsal and ventral aspects, and details.



Uichanco and Villanueva (1932) described and figured the macropterous male of this species, and Rao (1943) reported the discovery of apterous males and presented a photomicrograph.

Macropterous male. Body length about 1.2 mm. Antennae 9 or 10-segmented (several specimens have one antenna 9- and the other 10-segmented), abour 425 μ total length; 3rd segment about 54 μ long. Antennae clothed with digitiform setae about 27 μ maximum length, plus slender filamentous setae about 34 μ maximum length; Slightly thicker specialized sensory setae on 3 apical segments, about 30 μ maximum length; 1 each on 2 anteapical segments, 1 or 2 on apical segment. Head of normal male pseudococcid type, with a well-defined dorsomedial sclerite. Usual 3 pairs of eyes present, dorsal pair each about 24 μ in diameter, ventral pair each about 27 μ in diameter. Thorax normally developed.

Dermal discs mostly with 4 peripheral loculi, an occasional one with 3 or 5; somewhat less numerous than in apterous males. A group of 1 to 3 discs on lateral margins of each abdominal segment, plus a row, usually of 3 discs, across venter of abdominal segments 5 to 8. Several discs present near each spiracle, across venter of metathorax, and on lateral portions of prothorax; a row of 4 to 6 discs on each side of the anterior part of the head above the bases of the antennae. Tail-forming pore clusters confined to pair on 9th abdominal segment; each cluster containing about 50 to 60 stellate pores. The usual pair of long tail-forming hairs arising within each pore cluster much longer than those of apterous male, about 330 μ long; long hair at ventral margin of pore cluster of apterous males not developed in macropterous males. Body sparsely clothed with slender filamentous setae about 25 μ maximum length, generally shorter than those of apterous males; group of setae at lateral margins of abdominal segments only slightly longer, about 33 μ maximum length on 8th segment, much less noticeably developed than in apterous males. Digitiform setae confined to antennae and legs.

Penial sheath (fig. 3, L) about 135 μ total length; the median slit opening abruptly about half the distance from base to apex, its margins forming approximately right angles at this point; median lobes represented by small protuberances at the angles so formed. Posterior extension of sheath moderately elongate, slender, the apex slightly expanded and rounded, about 6 or 7 μ wide at 9 μ before tip.

Legs moderately short, hind femora about 155 to 160 μ long; clothed with digitiform setae about 27 μ maximum length, plus a few slender filamentous setae about 24 μ maximum length. Claw of hind tarsus about 33 μ long.

Abdominal sclerotization consisting of a median transverse patch on dorsum of segment 9; a pair of smaller patches, one on each side of the midline, on venter of segment 9; a pair of weak median transverse patches on dorsum of segment 8, one along posterior margin and one along anterior margin; a pair of weak transverse patches, one on each side of the midline of the dorsum, on the posterior margins of segments 2, 3, and 4.

Apterous male. (fig. 4) Body length about 1.25 mm. Antennae 8-segmented, about 225 μ total length; 3rd segment about 36 μ long. Antennae clothed with a few digitiform setae about 18 μ maximum length, plus filamentous setae about 34 μ maximum length. Slightly thicker specialized sensory hairs, about 30 μ maximum length, present on 2 apical segments, usually 1 on 7th segment and 2 or 3 on 8th segment. Head largely unsclerotized except for a pair of narrow arcuate sclerites dorsally near the posterior margin; sometimes an irregularly shaped area of weak sclerotization ventrally between antennae, and a similar weak area dorsally in front of the arcuate sclerites. Dorsal and ventral eyes absent; lateral ocelli present, each surrounded by sclerotized margins; a vestige of the postocular ridge extending ventrad from each eye. Thorax unsclerotized except for a vestigial pleurite at articulation of each coxa.

Dermal discs mostly with 4 peripheral loculi, as in macropterous males; fairly numerous on lateral margins of the thorax, particularly near the spiracles, and on lateral margins of anterior abdominal segments; posterior abdominal segments mostly with 2 to 4 discs on each side. A transverse row of 2 to 6 discs across the venter of each abdominal segment anterior to the 9th, the discs absent from the midventral region of the segment. Dorsum of each abdominal segment with 1 to 3 discs in a transverse row on each side, absent in the mediodorsal area. Tail-forming pore clusters limited to pair on 9th abdominal segment; each cluster containing about 30 stellate pores. The usual pair of tail-forming setae which arise within each pore cluster relatively short, each about 150 μ long; a much thicker, longer hair, about 250 μ in length, arising on the ventral margin of each pore cluster. Body fairly sparsely clothed with slender filamentous setae about 30 μ maximum length on dorsum; a row of 4 to 6 longer setae present on lateral margins of each abdominal segment, these about 60 μ maximum length on anterior segments, much longer on segments 7 and 8, about 150 μ maximum length on segment 8. Digitiform setae apparently confined to antennae and legs.

Penial sheath not differing noticeably from that of macropterous male.

Legs small, hind femora about 135 to 140 μ long; clothed with slender filamentous setae about 30 μ maximum length, plus a very few digitiform setae about 20 μ maximum length. Claw of hind tarsus about 30 μ long.

Abdominal sclerotization consisting of an irregular transverse area on dorsum of 9th segment; a pair of small patches on venter of 9th segment, one on each side of the midline.

Based on 20 specimens, 9 macropterous and 11 apterous; from various localities on Oahu, 1956 to 1959, (J. W. Beardsley), reared ex sugar cane.

Trionymus lounsburyi Brain

Trionymus lounsbury Brain, 1912. ANN. ENT. SOC. AMERICA 5(2):179, figs. 2, 3.

The original treatment includes a brief description and crude figure of the male.

Male. Body length about 1.1 mm.; available specimens macropterous. Antennae 10-segmented, about 580 μ total length; 3rd segment about 80 μ long.

Antennae clothed with short digitiform setae 15 to 18 μ long, plus slender filamentous setae about 45 μ maximum length. Slightly thicker specialized sensory hairs of 3 apical segments about 30 μ maximum length. Head with well-defined midcranial ridge dorsally; dorsomedial sclerite poorly developed; the usual ventral leg of the midcranial ridge anterior to the ventral eyes broadened to form a triangular sclerotized area extending to the base of the lateral branches of the midcranial ridge. Eyes small, dorsal pair each about 22 μ in diameter, ventral pair each about 24 μ in diameter.

Dermal discs mostly with 4 peripheral loculi, an occasional one with 3 or 5; 1 to 3 on each side of most of abdominal segments 3 to 8; 3 to 6 on each side of segment 2; 5 or 6 on each side of prothorax; 4 or so on anterior part of head between antennae. Tail-forming pore clusters confined to pair on 9th abdominal segment; each cluster consisting of about 40 stellate pores. Body sparsely clothed with slender filamentous setae mostly 12 to 18 μ long. Digitiform setae apparently confined to antennae.

Penial sheath (fig. 3, M) about 100 μ in length; with a pair of small but readily discernible median lobes; posterior portion tapering to a rounded apex, about 8 μ wide at 9 μ before tip.

Legs moderately small, hind femora about 150 μ long; clothed with slender filamentous setae about 24 μ maximum length, without digitiform setae. Claw of hind tarsus about 27 μ long.

Abdominal sclerotization poorly developed, consisting of a weak median transverse patch on dorsum of 9th segment, and a pair of small weak patches on venter of 9th segment, one on each side of the midline.

Based on 2 specimens: Mokuleia, Oahu, March 1959 (O. Degener), on *Crinum* lily.

Trionymus multiductus Beardsley

Trionymus multiductus Beardsley, 1959. Proc. Haw. Ent. Soc. 17(1):52, fig.5.

Male. Body length about 1.3 mm.; available specimens macropterous. Antennae 10-segmented, about 700 μ total length; 3rd segment about 84 μ long. Antennae clothed with digitiform setae about 27 μ maximum length, plus slender filamentous setae about 60 μ maximum length. Thicker specialized sensory hairs of 3 apical segments about 60 μ maximum length. Head with a broad well-developed dorsomedial sclerite. Eyes of moderate size, dorsal pair each about 30 μ in diameter, ventral pair each about 34 μ in diameter.

Dermal discs with 4 peripheral loculi; 1 or 3 on each side of abdominal segments 3 to 8; 4 to 6 on each side of segment 2; a few on each side of prothorax; apparently absent on head. Tail-forming pore clusters restricted to pair on 9th abdominal segment; each cluster consisting of about 60 to 70 stellate pores. Body sparsely clothed with slender filamentous setae about 30 μ maximum length; digitiform setae confined to antennae and legs.

Penial sheath (fig. 3, N) about 150 μ in length; without discernible median lobes; posterior portion relatively slender with rounded apex, about 10 μ wide at 9 μ before tip.

Legs moderately large, hind femora about 210 μ long; clothed with digitiform setae about 27 μ maximum length, plus slender filamentous setae about 36 μ maximum length. Claw of hind tarsus about 40 μ long.

Abdominal sclerotization consisting of a large, well-defined, median transverse patch on dorsum of segment 9: a pair of fairly large patches on venter of 9th segment, one on each side of midline; several small transverse patches on dorsum of segment 8 (apparently representing two interrupted transverse patches); a pair of small transverse patches, one on each side of midline, near the anterior margin on segments 3 and 4. Abdominal setae, particularly those of posterior segments, with prominent rings of sclerotization around their bases.

Based on 2 specimens: North Halawa Ridge, Oahu, March 15, 1958 (J. W. Beardsley), in folded-over leaves of *Syzygium sandwicensis* (Gray) Niedenzu.

Trionymus refertus Ferris

Trionymus refertus Ferris, 1948. Ins. Hawaii 5:261, fig. 141.

Male. Body length about 1.1 mm.; available specimens macropterous. Antennae 10-segmented, moderately short, about 480 μ in total length; 3rd segment about 50 μ long. Antennae clothed with slender digitiform setae about 26 μ maximum length, plus slender filamentous setae 45 μ maximum length. Thicker specialized sensory hairs of 3 apical segments about 45 μ maximum length. Head with a moderately well-developed dorsomedial sclerite. Eyes moderately small, dorsal pair each about 27 μ in diameter, ventral pair each about 30 μ in diameter.

Dermal discs mostly with 4 peripheral loculi, an occasional one with 3 or 5; 1 or 2 on each side of most of abdominal segments 2 to 8, occasionally absent on 1 or both sides of 1 or 2 segments; a few, usually 4 to 6, on each side of prothorax, apparently absent on head. Tail-forming pore clusters confined to pair on 9th abdominal segment; each cluster consisting of about 50 stellate pores. Body sparsely clothed with slender filamentous setae mostly 21 to 30 μ long. Digitiform setae confined to antennae and legs, plus a few on the head, mostly on the ventral portion, about 20 μ maximum length.

Penial sheath (fig. 3, O) about 110 μ in length; without discernible median lobes; posterior portion tapering to a moderately slender, nearly truncate apex, about 9 μ wide at 9 μ before tip.

Legs fairly small, hind femora about 135 μ long; clothed with digitiform setae about 35 μ maximum length, plus slender filamentous setae about 30 μ maximum length. Claw of hind tarsus about 27 μ long.

Abdominal sclerotization consisting of a fairly large median transverse patch on dorsum of segment 9; a pair of small patches on venter of 9th segment, one on each side of the midline; a pair of small, weak, narrow transverse patches on

anterior margin of dorsum of segment 8, one on each side of the midline; and an interrupted median transverse patch near posterior margin of dorsum of segment 8. Most of abdominal setae with narrow weak rings of sclerotization around their bases.

Based on 2 specimens: Wiliwilinui Ridge, Oahu, May 30, 1958 (J.W. Beardsley), ex rolled edges of leaves of *Syzygium sandwicensis* (Gray) Niedenzu.

Trionymus rostellum Lobdell

Trionymus rostellum Lobdell, 1930. ANN. ENT. SOC. AMERICA 23:219, pl. XI.

Male. Body length about 0.8 mm.; available specimens macropterous. Antennae 10-segmented, rather short, about 430 μ total length; 3rd segment about 45 μ long. Antennae clothed with very short digitiform setae about 10 μ maximum length, plus a few slender filamentous setae about 40 μ maximum length. Specialized sensory setae of 3 apical segments not appreciably thicker than digitiform setae, about 36 μ maximum length. Head with a broad, well-developed mediodorsal sclerite. Eyes small, dorsal pair each about 20 μ in diameter, ventral pair each about 23 μ in diameter.

Dermal discs mostly with 4 peripheral loculi, some with 5; 1 or 2 present on each side on each of abdominal segments 2 to 8; a few on each side of prothorax; 1 to 3 on each side of head between antennae. Tail-forming pore clusters confined to pair on 9th abdominal segment; each cluster consisting of about 35 to 40 stellate pores. Body sparsely clothed with slender filamentous setae about 18 μ maximum length; digitiform setae apparently confined to antennae and legs.

Penial sheath (fig. 3, P) about 80 μ total length; with a pair of small but readily discernible median lobes; posterior portion forming a relatively short, fine, apically rounded projection, about 6 μ wide at 9 μ before tip.

Legs small, hind femora about 115 μ long; clothed with filamentous setae about 21 μ maximum length on hind tibiae, plus a few digitiform setae about 18 μ maximum length. Claw of hind tarsus about 22 μ long.

Abdominal sclerotization consisting of a median transverse patch on dorsum of segment 9; and a pair of small patches, one on each side of the midline, on venter of segment 9.

Based on 4 specimens; Aina Haina, Honolulu, Hawaii, March, 1955 (J. W. Beardsley), reared ex grass.

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Recent Introductions for Biological Control in Hawaii—V

CLIFTON J. DAVIS
STATE DEPARTMENT OF AGRICULTURE AND CONSERVATION
HONOLULU, HAWAII

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INTRODUCTION

This paper includes a list of new introductions and additional releases of beneficial organisms for biological control in Hawaii made since the last published listing (Davis, 1959). The list is presented in table form and is preceded by a few notes on the status of organisms recently introduced for the control of snail, weed, and insect pests.

Snail Pest Control

A. *Lymnaea ollula* Gould (liverfluke snail).
Sepedon macropus Walker: The presence of the liverfluke, *Fasciola gigantica* Cobbold, in Hawaii dates back to 1892 and, according to Alicata (1946), fascioliasis is one of the most important parasitic diseases of cattle in the Hawaiian Islands. The principal intermediate host, *L. ollula*, has been present for many years and is probably of Asiatic origin. The snail, *Pseudosuccinea columella* (Say), has been recorded as a host under laboratory conditions (Alicata, 1953).

Earlier attempts were made to control the intermediate host by introducing natural enemies such as the fireflies, *Luciola cruciata* Motschulsky, *L. lateralis* Motschulsky, *Proturis hebes* Porter, and *Colophotia praeusta* Eschholtz, but although these were distributed widely, they apparently failed to become established.

In October of 1958, through the cooperation of Dr. Clifford Berg, Cornell University, Ithaca, New York, a shipment of marsh flies, *Sepedon macropus* Walker was obtained for trial on the liverfluke snail. Dr. Berg's *S. macropus* culture originated from material collected in Nicaragua. The larvae fed avidly on *Lymnaea* and *Physa* snail egg masses in the insectary, and killed and devoured the contents of snails of all ages.

Insectary propagation of *S. macropus* was very successful, and thousands of flies were released on the major islands of the Hawaiian Group. Eight months after the first release on Oahu, adult marsh flies were recovered and the species was found well established in a *Colocasia esculenta* (Linnaeus) (taro) habitat at Waiahole. It was also recovered on the Island of Kauai. This has been the first successful breakthrough in the attempt to establish fresh-water predators of the liverfluke snail in Hawaii.

TABLE I.

TABLE I.

NEW INTRODUCTIONS AND ADDITIONAL RELEASES FOR BIOLOGICAL CONTROL IN HAWAII

Pest Needing Control	Organism Introduced	Source	Collector	Date Rel'd. (1958)	No.	***Release Point
I SNAIL PESTS						
Achatina fulica Bowdich (giant African snail)	**Damaster blaptoides blaptoides* Kollar	Fukuoka, Japan	Professor K. Yasumatsu	8 May	102	Makiki Round Top Road, Oahu
				8 May	50	Haiku, Maui
	**Tefflus carinatus* Klug	Kenya, Africa	D. J. McCrae	9 July	13	Michelmore's, Hauula, Oahu
	**Tefflus zanzibaricus alluaudi* Sternberg	Kenya, Africa	D. J. McCrae	9 July	7	Michelmore's, Hauula, Oahu
Lymnaea ollula Gould (liverfluke snail)	*Dictya abnormis* Steyskal	Ithaca, New York	Dr. C. Berg	30 June	35	Kionaole Road, Oahu
II WEED PESTS						
Lantana camara L. var. *aculeata* (L.) Moldenke	**Aerenicopsis championi* Bates	Mocambo, Vera Cruz, Mexico	N.L.H. Krauss	6 May	12	MolokaiRanch, Molokai
				11 May	64	S. Greenwell Ranch, South Kona, Hawaii
				15 May	32	Near Pali Golf Course, Oahu
	**Octotoma scabripennis* Guerin	Cuernavaca, Mexico	N.L.H. Krauss	29 June	135	Kaakepa, Puna, Hawaii
				25 June	68	Tantalus, Oahu
Pluchea odorata (L.)Cass. (sour bush)	**Acinia fucata* Fabricius	Guatemala City, Guatemala	N.L.H. Krauss	6 Oct.	30	Waiau, Oahu
	Trichotaphe sp. (Clemens)	Mexico	N.L.H. Krauss	20 Jun'57	50	Papakolea, Oahu
III INSECT PESTS						
Spodoptera mauritia acronyctoides (Guenee)	**Apanteles ruficrus* Haliday	Manila, Philippine Islands	S. Capco	15 Aug.	35	Mundy's, Kailua, Oahu
Maruca testulalis (Geyer)	*Bracon* sp.	Tabogo Island, Panama	N.L.H. Krauss	18 Nov.	100	Kaneohe, Oahu

*Previously introduced.
***Applies to initial releases only.

B. *Achatina fulica* Bowdich (Giant African snail).

Gonaxis kibweziensis (Smith) and *G. quadrilateralis* (Preston): These East African carnivorous snails were frequently found in the egg clutches of the African snail, *A. fulica*, and it was suspected that in addition to devouring the emerging infants, they were also preying upon the eggs. This was subsequently confirmed by microscopic examination in which both species were observed rasping the shells and devouring the embryonic snails. *G. kibweziensis* was found well established in four of twelve release points while *G. quadrilateralis* was recovered in eight of seventeen release points.

Euglandina rosea (Ferrusac): Although well established and widely distributed since its introduction in 1955, subnormal rainfall and a possible population shift to higher areas during 1959 may be factors responsible for the scarcity of *Euglandina* in areas of former abundance.

Weed Pest Control

A. *Lantana camara* var. *aculeata* (L.) Moldenke

The control of this range pest seems a step closer as a result of incessant attack by introduced enemies. Foremost among these is the noctuid moth, *Hypena jussalis* Walker, which got underway during the latter part of 1958 (Davis, 1959). This species remained abundant during the early months of 1959, and by April and May many square miles of lantana at Ulupalakua, Maui were completely defoliated. Next in order of importance was the pyralid, *Syngamia haemorrhoidalis* Guenée. Field observations at a number of locations in the state suggested that activity by this defoliator often preceded that of *Hypena*. Populations of both species appeared to level off during the summer months. During this period the lantana tingid, *Teleonomus scrupulosa* Stål, became increasingly active, and up to 100% defoliation resulted in many localities between sea level and 2,000 feet elevation. Overlapping of activity occurred not only with the aforementioned insects but also with the leaf-mining tineid moth, *Cremastobombycia lantanella* Busck, the noctuid moth, *Catabena esula* Druce, and the garden looper, *Plusia chalcites* (Esper).

B. *Melastoma malabathricum* Linnaeus

The recovery and establishment of *Bocchoris fatualis* Munro at Knudsen Gap, Kauai, was reported by Resident Entomologist Stephen Au in April, 1959. This pyralid moth was introduced from Paete, Laguna Province, Philippine Islands in 1957. The caterpillars feed on the foliage.

C. *Opuntia megacantha* Salm-Dyck

Lagocheirus funestus Thomson, a cerambycid borer introduced from Australia in 1951, was increasingly active and is extending its range. It was observed in September along the Kohala Road, Hawaii, approximately two miles from the junction of the Kohala and Kawaihae Roads.

Insect Pest Control

A. *Peregrinus maidis* (Ashmead) (corn leafhopper).
The mirid bug, *Cyrtorhinus lividipennis* Reuter, which feeds on the eggs of the corn leafhopper, was introduced into Hawaii from Guam in 1939, 1951 and 1952. It was particularly active on Oahu during 1959, and was recovered for the first time at Kapoho, Island of Hawaii, in February, 1959.

B. *Siphona irritans* L. (horn fly).

The scarabaeid dung beetle, *Onthophagus catta* (Fabricius) (determined by Dr. O. L. Cartwright), was recovered for the first time at Wahiawa, Oahu by E. J. Ford Jr. It has since appeared in light traps operated by HSPA entomologists at Waipio, and Ewa, Oahu. *O. catta* was collected in Southern Rhodesia and Kenya, Africa by N. L. H. Krauss, and was liberated on Oahu in 1957.

Miscellaneous

One hundred five cattle egrets, *Bubulcus ibis* (Linnaeus), and 21 barn owls, *Tyto alba* (Scopoli), were liberated for horn fly and rodent control duting 1959. The cattle egrets were released on Oahu, Kauai, Molokai, Maui, and Hawaii, while the barn owls were released on Hawaii, Oahu, and Kauai.

The propagation and testing of all organisms considered for liberation were conducted by Mr. Q. C. Chock, State Entomologist, assisted by C. J. Davis, Assistant State Entomologist, and by Miss Mabel Chong, Insectary Supervisor. The assistance of collaborators in making insect shipments, and determinations by the Insect Identification and Parasite Introduction Section, U. S. Department of Agriculture, is gratefully acknowledged.

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New Species of Cyrtopeltis from the Hawaiian Islands with a Revised Key (Hemiptera: Miridae)

J. C. M. CARVALHO
MUSEU NACIONAL, BRASIL
AND
ROBERT L. USINGER
UNIVERSITY OF CALIFORNIA, BERKELEY

Submitted for publication January, 1960

The genus *Cyrtopeltis* was first reported from Hawaii by Kirkaldy (1902) on the basis of specimens collected by R. C. L. Perkins for the FAUNA HAWAIIENSIS. Having described a perfectly distinct species, *C. hawaiiensis*, from Haleakala Crater, Kirkaldy later (1910) confused the situation by lumping Oahu specimens under the same name. Perkins (1911) corrected this error, describing the Oahu specimens as *C. confusa*. Perkins' material is before us and bears his handwritten notes. From this information it appears: 1. that *C. hawaiiensis* Kirkaldy (represented by a single specimen from Haleakala Crater) is a very distinctive species, possibly even a distinct subgenus, which occurs on Maui; 2. that the specimen from the Waianae coast of Oahu supposed by Perkins to agree "exactly with Kirkaldy's description" is actually very close, if not identical, with *C. confusa*; 3. that *C. confusa* Perkins is a common species on Mt. Tantalus, Oahu.

In 1924, an American species, *Cyrtopeltis modesta* (Distant), was introduced (Swezey, 1924) and has since become a pest of tobacco and tomato (see Tanada and Holdaway, 1954, for excellent summary). Zimmerman (1948) brought together information on the three known species and gave a key to separate them.

Meanwhile, the taxonomic status of genera and subgenera in this section of the Dicyphinae was being debated by authorities elsewhere in the world and the nomenclature of the tomato bugs was complicated by excessive synonymy and bewildering homonymy, not entirely covered by the vacillating Rules passed at successive meetings of the International Commission on Zoological Nomenclature. The latest summary of this situation is by China and Carvalho (1952). According to this the Hawaiian species belong to the subgenus *Engytatus* of *Cyrtopeltis*. *Engytatus* is stated to be "entirely American" and the opinion is expressed that "the Hawaiian species must have been derived from America and not from the West". Unfortunately, China and Carvalho erred in their treatment of the nomenclature of the tomato bug, calling it *luridus* (Gibson) on page 160 and *modesta* (Distant) on the on page 116. Zimmerman (1957) in a supplement to his treatment of the Hemiptera in INSECTS OF HAWAII, gave the corrected names and synonymy for the three Hawaiian species of *Cyrtopeltis*.

The purpose of the present paper is to correct certain errors in the record as detailed above, to add locality and host records on the basis of abundant material collected by Swezey, Timberlake and Usinger, and to describe two new species. A revised key is included in order to place the new species.

Types of the new species are deposited in B. P. Bishop Museum. The holotype and allotype of *hawaiiensis* Kirkaldy are in the British Museum (Natural History): BMNH–655, Sandwich Is. 1913–323. A hololectotype, male, and allolectotype, female, of *C. confusa* Perkins from Mount Tantalus are hereby designated from the original material in Perkins' collection. Since this material was found in the collection of the Hawaiian Sugar Planters' Association Experiment Station the types are deposited there.

Distribution and Host Records

Interesting anomalies are apparent in the pattern of distribution of the endemic species of *Cyrtopeltis*. For example, no species is known from more than one island (the Molokai record for *hawaiiensis* may represent a new species) and no specimen has ever been collected on the large island of Hawaii. It is difficult to believe that this represents the true state of affairs and it seems probable that specialized collecting on the appropriate host plants will result in additional species that conform more nearly to the usual pattern of endemic insects in the Hawaiian Islands.

The distribution of *C. hawaiiensis* is likely to be of unusual interest. A male and female from 6,000 feet on Haleakala differ slightly in pubescence and strikingly in shape of pygophore from typical examples in Haleakala Crater. Also, specimens from near the summit vary in length of antennal segments. A pair from Molokai may also prove to be different. Because of limited material collected in a haphazard manner without reference to this particular problem, it seems best merely to call attention to the need for further field work on *C. hawaiiensis*.

Early host records for *Cyrtopeltis* included *Gouldia*, *Straussia*, *Touchardia*, and *Dodonaea*, but not one of the several hundred specimens before us, collected over a period of fifty years, is recorded from these hosts. All *C. hawaiiensis* specimens are from *Dubautia* (*Railliardia*), a Composite. *C. confusa* is recorded exclusively from *Cyrtandra cordifolia* (Family Gesneriaceae) and the two new species, *lysimachiae* and *phyllostegiae*, were collected on *Lysimachia* (Family Primulaceae) and *Phyllostegia* (Family Labiatae).

The following field notes on host specificity are quoted from Usinger's Hawaiian notebook: "April 5, 1936. Collected up Poamoho Valley following the C.C.C. trail along the ridge to the left of the Valley. *Cyrtandra cordifolia* was very common. Took the maculated *Cyrtopeltis* on it whenever I tried. Another smaller *Cyrtandra* was seen in a dense thicket and had the characteristic leafhoppers but no *Cyrtopeltis* bugs, showing specificity of insects correlated with plant species.

On *Phyllostegia hirsuta* Benth. took a new species of *Cyrtopeltis* not uncommonly. A single small *Cyrtandra* plant was found amidst the *Phyllostegia* and on it was found *C. confusa* (maculated) showing absolutely no intermixture."

Thus the evidence is strong that the endemic *Cyrtopeltis* are host specific and that they are restricted to plant species which are not closely related. Whether the group is really absent from the Island of Hawaii remains to be proved by future field work.

Key to the Hawaiian Species of Cyrtopeltis

1. Body color yellow, without a pattern of dark marks on hemelytra and appendages; densely beset with suberect black bristles. Pronotum two and one-half times as wide across humeri as long on mid-line behind collar. Maui: Haleakala, 6,000 feet to the Crater, on *Dubautia* (=*Railliardia*). Molokai: Puu Kole Kole, on *Dubautia* . . . . . **hawaiiensis** Kirkaldy (1902)

   Body color pale, testaceous, sometimes tinged with green, the hemelytra more or less infuscated on clavus and apices of corium and cuneus and the antennae brown at least on base of first and second segments; beset with finer, usually pale hairs. Pronotum narrower, about twice as wide across humeri as long on mid-line behind collar 2

2. Eyes very large, each eye equal to or wider than interocular space. Kauai, Oahu, Molokai, Maui, Hawaii. Tomato and tobacco . . . . . **modesta*** Distant (1884)

   Eyes smaller, distinctly narrower, as seen from above, than interocular space 3

3. Rostrum exceeding apices of hind coxae; cell in membrane six times as long as wide. Oahu, on *Cyrtandra* . . . . . **confusa** Perkins (1911)

   Rostrum not exceeding apices of hind coxae; membranal cell four times as long as wide 4

4. Rostrum short, reaching only to apices of front coxae. Kauai, *Lysimachia* . . . . . **lysimachiae,** n. sp.

   Rostrum longer, reaching nearly to apices of hind coxae. Oahu, *Phyllostegia* . . . . . **phyllostegiae,** n. sp.

Cyrtopeltis (Engytatus) phyllostegiae, new species (figs. 2, 9)

Body slender with costal margins subparallel; pubescence short, pale, and inconspicuous. Color pale testaceous, the hemelytra translucent with clavus more or less infuscated except at base, corium brown along inner apical margins with a discrete brown spot at outer apex, cuneus with a brown spot at inner apex, membrane clear except for vein and immediate surroundings of cell. Collar and

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*The gender of *Cyrtopeltis* is clearly feminine as indicated in Fieber's original description (1861).

base of head above yellow. Eyes brown. Antennae with a brown ring at middle of first segment, another at base of second segment, third and fourth segments generally infuscated. Rostrum and tarsi brown at extreme apices. Brown color in extremely pale specimens restricted to apices of coria, cunei, eyes, antennae and apices of rostrum and tarsi.

Male. Head 0.4 mm. wide, slightly longer than wide, 13::12. Eyes 0.083 mm. wide, less than half as wide as interocular space, 2½::7. Sides of head converging behind eyes to collar, postocular distance equal to length of an eye. Antennae two-thirds as long as body, proportion of segments 6½:23:21:11; length of segments 0.216 mm., 0.766 mm., 0.7 mm., 0.366 mm. Rostrum reaching apices of hind coxae, 1.36 mm. long, segments subequal.

Pronotal collar 0.33 mm. wide and 0.06 mm. thick, distinctly swollen. Pronotum half again as wide across humeri as long at middle behind collar, greatest width 0.7 mm. Sides and hind margin concave, disk convex, glabrous, with callosities faintly distinguished by an arcuate line behind and a longitudinal median impression extending back from anterior margin.

Scutellum slightly shorter, 0.33 mm., than wide at base, 0.43 mm. Costal margin of corium 1.26 mm.

Male pygophore and right clasper as figured, outer or terminal branch of pygophore tapering, inner arm slender and bent at apex.

Female. Similar to male but with slightly different antennal proportions, 7:20:18:11. Postocular distance shorter than length of an eye, 2::3½; pronotum slightly more than half again as wide across humeri as long behind collar, 24::14, length of costal margin of corium 1.4 mm.

Length: Male 3.1 mm., female 3.3 mm. (from apex of head to tip of membrane).

Holotype male, allotype female, and fifteen paratypes: Poamoho Trail, Oahu, April 5, 1936, on *Phyllostegia hirsuta*, R. L. Usinger collector.

Cyrtopeltis (Engytatus) lysimachiae, new species (figs. 3, 6, 7)

Body slender, costal margins subparallel, pubescence fine, pale, longer at sides of hemelytra than elsewhere. Color uniformly pale testaceous, except for a brown spot at middle of cuneal fracture and another at apex of cuneus. Veins of membrane cell infuscated. Eyes dark brown. Antennae with a brown ring on basal half of first segment, brown at base of second segment and generally but faintly infuscated apical segments. Apex of rostrum and apices of tarsi brown.

Male. Head 0.46 mm. wide, slightly shorter than wide, 13::14, eyes 0.1 mm. wide, seen from above, less than half as wide as interocular space, 3::8. Sides

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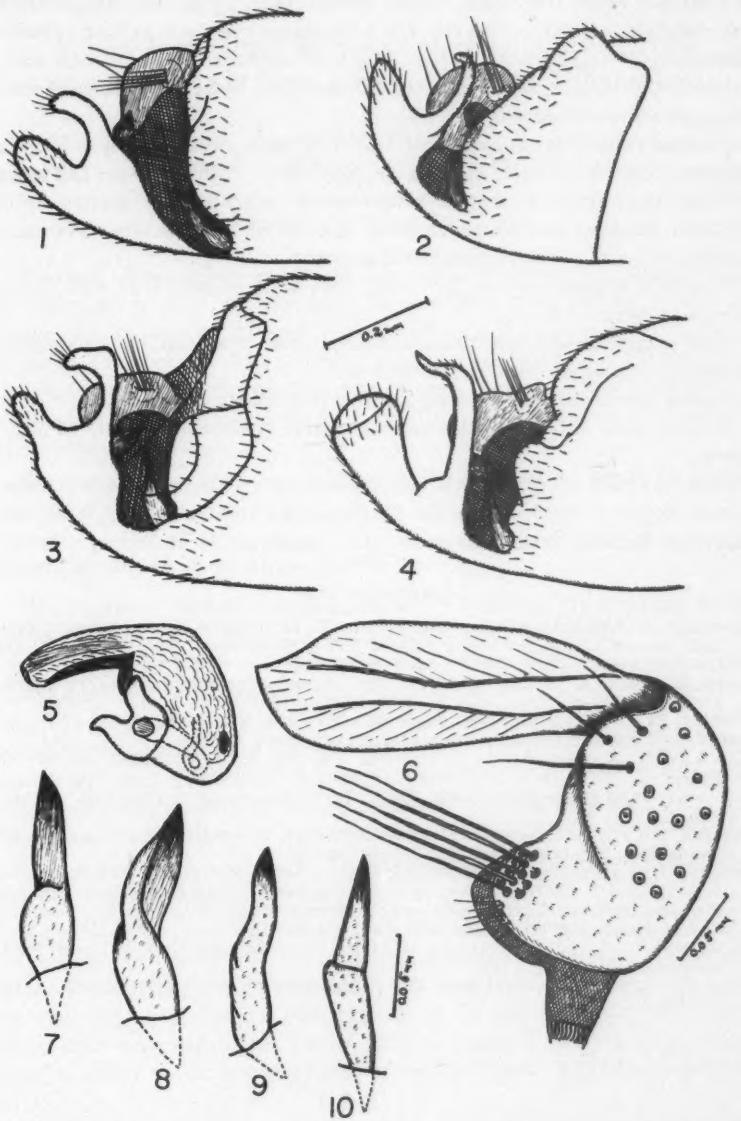
FIG. 1. *Cyrtopeltis hawaiiensis* Kirkaldy, pygophore; FIG. 2. *C. phyllostegiae*, n. sp. pygophore; FIG. 3. *C. lysimachiae*, n. sp., pygophore; FIG. 4. *C. confusa* Perkins, pygophore; FIG. 5. *C. confusa* Perkins, aedeagus; FIG. 6. *C. lysimachiae*, n. sp. left clasper; FIG. 7. *C. lysimachiae*, n. sp., right clasper; FIG. 8. *C. confusa* Perkins, right clasper; FIG. 9. *C. phyllostegiae*, n. sp. right clasper; FIG. 10. *C. hawaiiensis* Kirkaldy, right clasper. Figures of the pygophore of *C. modesta* (Distant) are given in Carvalho (1947).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of head very briefly converging behind eyes to collar, postocular distance much less than half the length of an eye, 1½::5. Antennae two-thirds as long as body, proportion of segments 9:25:30:14; length of segments 0.3 mm., 0.83 mm., 1.0 mm., 0.46 mm. Rostrum reaching only to apices of front coxae, 0.886 mm. long, proportion of segments 8:6:6:6½.

Pronotal collar 0.41 mm. wide and 0.086 mm. thick, swollen and with laterally swollen acetabula on either side visible from above. Pronotum over half again as wide across humeri as long at middle behind collar, 25½::14, greatest width 0.85 mm. Sides and hind margin concave, disk convex, anterior lobe (callosities) swollen and with a faint longitudinal impression.

Scutellum slightly shorter, 0.43 mm., than wide at base, 0.53 mm. Costal margin of corium 1.93 mm.

Male pygophore and right clasper as figured, outer or terminal branch knobbed or enlarged, inner arm slender and hooked.

Female. Similar to male but with antennal proportions 9:21:23:13.

Length: Male 4.0 mm., female 4.2 mm. (from apex of head to tip of membrane).

Holotype male, allotype female, and 16 paratypes: trail from Kokee to Kalalau, Kauai, August 5, 1925, *Lysimachia*, O. H. Swezey collector. Eleven additional paratypes, Kalalau, Kauai, August 20, 1921, *Lysimachia*, O. H. Swezey collector.

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A New Bibio from the Sierra Mountains, California, and a New Plecia from Malaya (Diptera: Bibionidae)[1]

D. Elmo Hardy
HAWAII AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF HAWAII
HONOLULU, HAWAII
(*Submitted for publication April, 1960*)

Two new species of bibionids are on hand which need names so that they may be discussed in other publications. The new *Bibio* from the high Sierras of California has been received from Dr. A. T. McClay of the University of California at Davis. This species will be treated in a California Insect Survey Bulletin on the family Bibionidae, which is now in press. The new *Plecia* from Malaya was sent to me for determination by R. W. Crosskey, Commonwealth Institute of Entomology, London.

The drawings have been prepared by Mrs. Phyllis Habeck. I greatly appreciate this valuable assistance.

Bibio sierrae, new species (figs. 1, a-h)

This species is near *B. knowltoni* Hardy but is distinct. It is readily differentiated by having all black pile rather than yellow; the posterior veins concolorous with the wing membrane rather than brown; the r-m crossvein about one-half as long as the basal section of the radial sector rather than equal in length to the basal portion of Rs; the antennae distinctly thickened at the base of the flagellum rather than almost straight-sided; the spurs of the hind tibiae slender and sharp-pointed rather than with the outer spur blunt; the front of the female entirely polished black, not opaque; and with long black hair over the front of the female rather than with short, yellow pile.

A medium-sized, shining black-bodied species with predominantly rufous legs. The pile is entirely black.

Male. *Head:* The eyes are thickly pilose. The ocellar triangle is polished black and extends well above the eye margin. The antennae and palpi are entirely black. The flagellum is eight segmented and tapers gradually from the base to the apex (fig. 1, a). The last two segments of the palpi are about three times longer than wide (fig. 1, b). *Thorax:* Entirely polished black, lacking even a tinge of rufous on the humeral ridges or on the halteres. *Legs:* The coxae and

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[1] Published with the approval of the Director of the Hawaii Agricultural Experiment Station as Technical Paper No. 480.

trochanters are polished black. The bases of the tibiae, the narrow apices and bases of the femora, and the apical two or three segments of the tarsi are black; the legs are otherwise rufous except for an irregular arrangement of small black spots which extend down each posterodorsal surface of the hind tibiae (fig. 1, c). The inner spur of the front tibia is one-third to two-fifths as long as the outer spur (fig. 1, d). The apical spurs on the hind tibiae are slender and sharp-pointed. The hind femora and tibiae are moderately clavate, the femora are distinctly thicker than the tibiae. The hind basitarsi are about three times longer than wide and approximately equal in length to the next two tarsal segments. *Wings:* Almost entirely hyaline, infuscated in the costal cell beyond the humeral crossvein. The stigma is dark brown and is large and conspicuous. The costa ends slightly beyond the apex of Rs. The anterior veins are dark brown, the posterior veins are hyaline, concolorous with the wing membrane. *Abdomen:* Entirely shining black, slightly tapering posteriorly, broadest at segment two. The ninth tergum is about two times wider than long and has a moderate V-shaped concavity in the middle of the hind margin, this extends approximately half the length of the segment (fig. 1, e). The claspers are moderately long and slender (fig. 1, g).

Length: Body and wings, 6–6.25 mm.

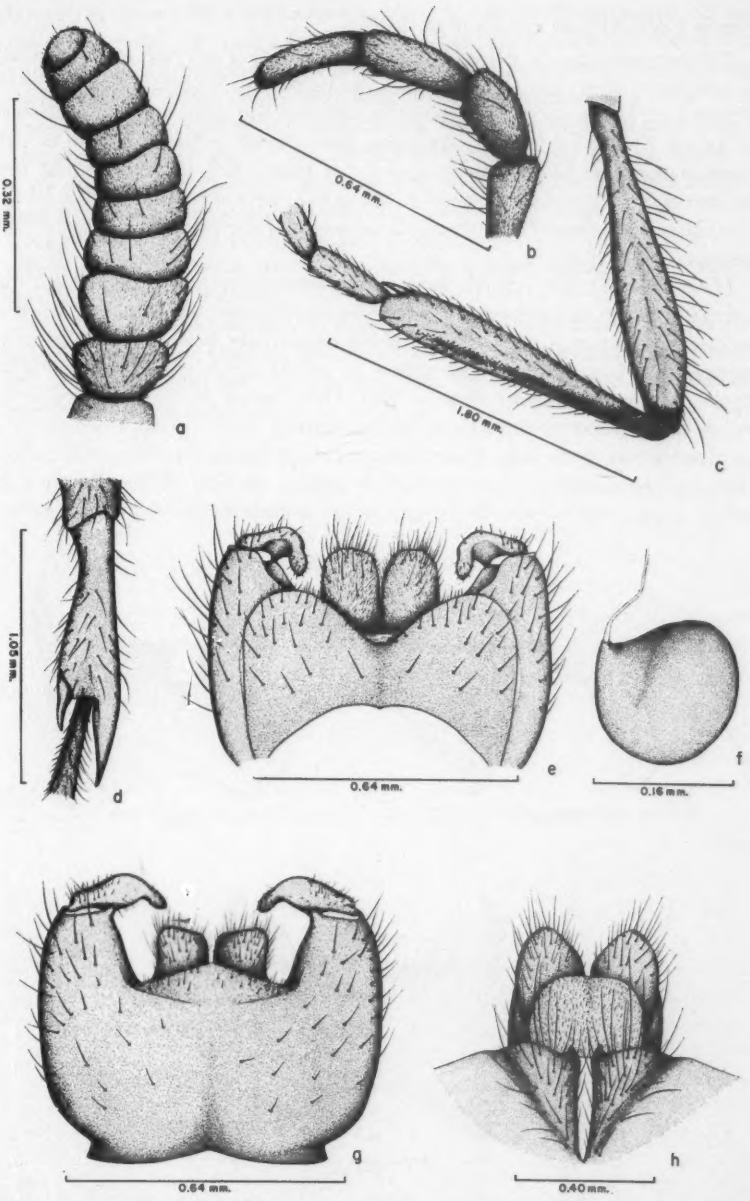
Female. The body and leg coloration, the characteristics of the antennae, palpi, and front tibiae are as in the male. The head is entirely smooth, polished black; as seen from direct dorsal view it is about as wide as long. The portion of the head behind the compound eyes is approximately equal in length to the eyes. The head is scarcely developed in front of the eye margin; this portion is about equal in length to the scape of the antenna. The hind legs are similar in most respects to the male; the tibiae and tarsi are just slightly more slender. The wings are entirely infuscated, slightly more brownish on the anterior portion and rather broad, about 2.6 times longer than wide. The cerci are oblong in shape. The egg guides are shaped as in figure 1, h. The inner posterior portion of each is slightly gibbose and densely setose. The spermathecae are oval in shape (fig. 1, f).

Length: Body, 5.4–5.7 mm.; wings, 6.2–6.8 mm.

Holotype male, allotype female, and thirteen paratypes, all females, from Dana Fork, Tuoluomne River, Yosemite National Park, California, 10,000 ft. elevation, August 7, 1959 (D. W. Price).

The type, allotype, and seven paratypes are being returned to the University of California at Davis. The remainder of the paratypes are being deposited in the following collections: United States National Museum, Bernice P. Bishop Museum, and the University of Hawaii.

FIG. 1. *Bibio sierrae*, n.sp. a. antennae; b. last three segments of palpus; c. hind leg of male; d. front tibia of male; e. male genitalia, dorsal; f. spermatheca; g. male genitalia, ventral; h. female ovipositor, ventral.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e
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f
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g
0.40 mm.
h

Plecia pagdeni, new species (figs. 2, a-b)

This species is closely related to *P. subvarians* Walker and runs to this species in couplet 34 of my key to the *Plecia* of the Pacific and Southeast Asia (PACIFIC SCIENCE 12(3):188, 1958). The genitalia, however, are quite different as shown in figures 2, b and 2, c. The submedian lobes on the posterior margin of the ninth sternum are broad, almost quadrate at apices, and are separated on the median margin by a distance equal to about half the width of one of the lobes. The claspers are slender, less than half the width of the submedian lobes of the sternum (fig. 2, b).

Male. *Head:* Ocellar tubercle prominent. Antennae entirely black, except for a tinge of rufous on the base of the first flagellar segment. Flagellum with seven segments. Rostrum inconspicuous, folded beneath the head. *Thorax:* Entirely orange to rufous. Halteres with yellow to rufous stems and brown to black knobs. Mesonotal furrows distinct. *Legs:* Dark brown to black, tinged with yellow at the bases of the femora. Rather densely black pilose. I see no distinctive features in the legs. Front basitarsus about one-half as long as the tibia. Hind basitarsus slightly over one-third as long as the tibia. *Wings:* Faintly and evenly tinged with brown. The stigma is not differentiated. Vein R2+3 enters

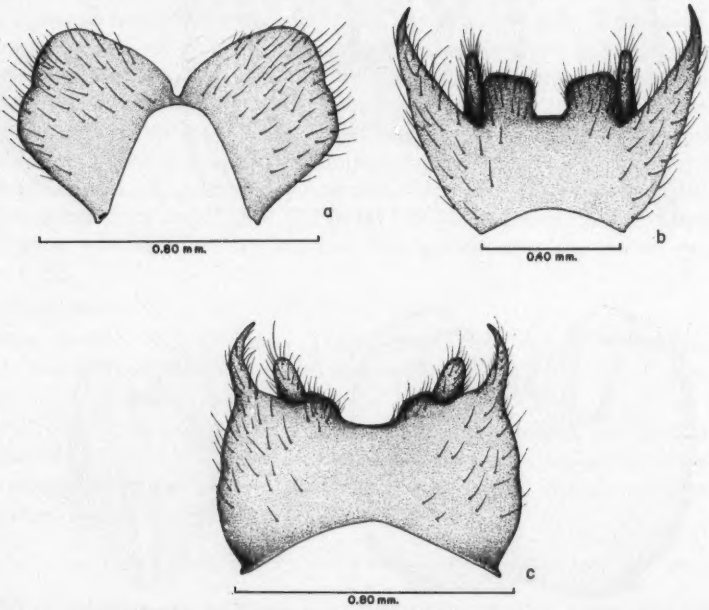

FIG. 2. *Plecia pagdeni,* n.sp. a. male genitalia, dorsal; b. male genitalia, ventral. *P. subvarians* Walker, c. male genitalia, ventral.

the costa at about a 50° angle to R4+5. *Abdomen:* Entirely black, densely covered with brown pollen and rather densely black pilose. The ninth tergum has a deep V-shaped concavity on the posterior margin and a U-shaped concavity on the anterior margin, these almost completely bisect the segment (fig. 2, a). The posterior lateral margins of the ninth sternum are developed into slender, sharp-pointed lobes which extend well beyond the apices of the tergum. A pair of broad, flat-topped submedian lobes are also present on the posterior margin, these are at least twice as wide as the slender claspers (fig. 2, b).

Length: Body, 4.3–4.5 mm.; wings, 6.2–6.4 mm.

Holotype male and six male paratypes from Sungei, Penang Hills, Malaya, Sept. 9, 1957 (H. T. Pagden).

The type and three paratypes have been returned to the Commonwealth Institute of Entomology, London. Two paratypes have been retained in the University of Hawaii collection and one has been deposited in the United States National Museum collection.

The Klu Beetle, Mimosestes sallaei (Sharp), in Hawaii (Coleoptera: Bruchidae)[1]

ALDEN D. HINCKLEY
UNIVERSITY OF HAWAII
HONOLULU, HAWAII

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In 1918, a bruchid new to Hawaii was reared from klu pods collected "in the Punchbowl district of Honolulu" and identified as "*Bruchus sallaei* Sharp" by Bridwell (1919). Two general studies of the Bruchidae, which have included observations on the bionomics and parasites of this species, were those conducted by Cushman (1911) in Texas and Bridwell (1920) in Hawaii. During the period from September 1957 to March 1960, additional notes on the nomenclature, bionomics, competitors and parasites of the klu beetle were made by the present author in connection with research on mortality in natural populations of bean beetles in Hawaii.

NOMENCLATURE

Of the twelve bruchids established in Hawaii, the klu beetle and eight other species have long been treated as members of the genus *Bruchus* (=*Mylabris* or *Laria*), although Bridwell (1918) recognized "the desirability of separating the natural genera confused under the old genus *Bruchus*". Bridwell (1929) partially accomplished the necessary revision by raising *Acanthoscelides* and *Callosobruchus* from subgeneric to generic standing. The revision was continued in another paper by Bridwell (1946), in which Nearctic and Neotropical species were removed from *Bruchus*, several being designated as types of new genera. In that paper, Bridwell also separated the subgenus *Zabrotes* from *Spermophagus* and raised it to generic level. Furthermore, he treated *Caryedon* (=*Caryoborus* or *Pachymerus*) *gonagra* (Fabricius) as a synonym of *C. fuscus* (Goeze). The latter change was strongly opposed by Southgate and Pope (1957) but the other taxonomic reforms have, with some qualifications, generally been accepted (*vide:* Bradley, 1946; Muesebeck *et al.*, 1951; Southgate, Howe and Brett, 1957).

There apparently is another synonym in the literature on bruchids in Hawaii since *Megacerus alternatus* Bridwell was first recorded as "*Bruchus* sp. near *coryphae* Olivier" (Swezey, 1925), and it seems probable that *B. coryphae* variety *lineatipennis* Pic (1938), described from Hawaiian specimens, should be synonymized with *M. alternatus*.

[1] A portion of a dissertation submitted in partial fulfillment of the requirements for the degree Doctor of Philosophy in Entomology at the University of Hawaii.

The accepted names and pertinent synonyms of bruchids in Hawaii are now as follows:

1. **Acanthoscelides obtectus** (Say)
   Bruchus obtectus Say
   Bruchus irresectus Fahraeus, Bridwell 1929
2. **Algarobius prosopis** (Leconte)
   Bruchus prosopis Leconte, Bridwell 1946
3. **Bruchus phaseoli** Gyllenhal
4. **Callosobruchus chinensis** (Linnaeus)
   Bruchus chinensis (Linnaeus)
   Curculio chinensis Linnaeus, Bridwell 1929
5. **Callosobruchus maculatus** (Fabricius)
   Bruchus maculatus Fabricius
   Bruchus 4-maculatus Fabricius, Bridwell 1929
6. **Caryedon gonagra** (Fabricius)
7. **Megacerus alternatus** Bridwell
   Bruchus coryphae Olivier
   var. *lineatipennis* Pic, *new synonym*
8. **Mimosestes amicus** (Horn)
   Bruchus amicus Horn, Bridwell 1946
9. **Mimosestes sallaei** (Sharp)
   Bruchus sallaei Sharp, Bridwell 1946
10. **Stator limbatus** (Horn)
    Bruchus limbatus Horn, Bridwell 1946
11. **Stator pruininus** (Horn)
    Bruchus pruininus Horn, Bridwell 1946
12. **Zabrotes subfasciatus** (Boheman)
    Spermophagus subfasciatus Boheman, Bridwell 1946
    Spermophagus pectoralis Sharp, Bridwell 1940

Numbers 1 and 4 were designated as new genotypes in Bridwell (1929) and numbers 2, 9 and 11 in Bridwell (1946). Numbers 3, 4, 5 and 6 apparently originated in the Palearctic, Oriental or Ethiopian Regions and have become widely distributed through commerce. The other species, including *Mimosestes sallaei*, originated either in the Neotropical Region or in the southern portions of the Nearctic Region.

Bionomics

In Hawaii, *M. sallaei* has been reared from klu, *Acacia farnesiana* (L.) Willd. and kiawe, *Prosopis chilensis* (Molina) Stuntz, both plants being of Neotropical origin. Host lists presented by Zacher (1952) suggest that, in addition, it may

be able to develop on *Caesalpinia coriaria* (Jacq.) Willd. and *Ceratonia siliqua* L., ornamentals uncommonly grown in Hawaii (Neal, 1948:369 and 381). On kiawe, it is associated with three other species of bruchids, *Algarobius prosopis*, *Mimosestes amicus* and *Caryedon gonagra*, but the adults, although all 5 to 6 mm. long, can be distinguished readily. The dorsum of *M. sallaei* is reddish brown with grey lines whereas that of *M. amicus* is uniformly grey. (This difference appeared superficial but unsuccessful attempts to interbreed *M. amicus* and *M. sallaei* supported their specific standing.) Both species of *Mimosestes* can be separated from *Algarobius prosopis* by the scutellum which in *Mimosestes* is broader than long, and in *Algarobius* is longer than broad. The other bruchid reared from kiawe, *Caryedon gonagra*, can be distinguished not only in the imaginal but also in the larval and pupal stages. The larva has functional legs, the pupa is found outside the seed in a heavy cocoon, and the adult has very much enlarged hind femora; all of these characteristics being absent in the other three bruchids.

Since *M. sallaei* is the only bruchid commonly reared from klu, this host was used in most of the following studies. *M. sallaei* apparently first oviposited on the basal end of green klu pods, sometimes as early as the fifth week of pod development. When the pods started turning brown, during the 10th to 12th week, oviposition generally increased. The attack continued for months, oviposition occurring even on pods in which all the seeds had been destroyed.

Eggs were attached to the pod surface by means of a thin lacquer-like film which was most conspicuous around the periphery of isolated eggs and less so at the edge of clusters. Some of the clusters contained more than 10 overlapping eggs. Although the eggs could be laid anywhere on the surface of the pod, certain points, next to ridges or inside wounds, seemed to be favored.

The incubation period for 30 eggs laid in June, 1958, ranged from 5 to 9 days, averaging 7. Those laid in cooler months apparently took a few days longer to develop.

The egg is about 0.8 mm. long and 0.4 mm. wide, one end being slightly pointed. The translucent chorion permitted the following observations to be made during the incubation period: on the first day, many globules and four or five transverse lines could be seen; on the second, there was an apparent concentration of darker embryonic tissue in the pointed end, with varying degrees of concavity in this dark mass by the third day; then on the fourth day the head everted and the embryo began to elongate, a process which continued for the last 2 or 3 days of embryonic development.

Laboratory studies showed that feeding during the adult stage increased oviposition. The maximum number of eggs laid by an unfed female was usually about 80 but a female fed honey could lay up to 140 eggs.

The larva emerged from the blunt end of the egg, boring directly into the pod and filling the chorion with yellow frass. Those larvae emerging from eggs that were not firmly attached apparently found penetration difficult, presumably owing to lack of purchase. When a larva did manage to bore through the thick

shell of a klu pod and reach a seed, it could continue to bore anywhere on the surface of the seed, but quite frequently it entered along the shallow groove in the seed coat which approximately outlines the cotyledons. The whole process of hatching and penetration apparently took several days.

Larval development within the seed usually lasted from 4 to 5 weeks, although it sometimes required as long as 8 weeks when the temperature was low or nutrition was poor. Counts of larval exuvia in a single seed suggested the presence of three instars, but there may be more. Randolph and Gillespie (1958) reported 4 instars for *Bruchus brachialis* Fahr, and de Luca (1956) observed 6 in studies of *Bruchus lentis* Fröhlich.

Cushman (1911) stated that the maximum pupal period for *M. sallaei* in Texas was 8 days. In Hawaii, however, pupation was found to range from 6 to 10 days. The adult, about 5 mm. long, remained in a teneral state for approximately 2 days, then chewed its way out leaving door-like discs about 2 mm. wide in both the seed and the pod.

In summary, the shortest times recorded for the various stages were as follows: egg, 5 days; larva, 24 days; pupa, 6 days; and teneral adult, 1 day. The total minimum period from oviposition to emergence was 36 days. Rearings indicated that males and females developed at similar rates and were equally abundant.

Adults of *M. sallaei* held without food or water died 20 to 50 days after emergence, but when fed with honey, they could survive up to 3 months.

Adults have been observed feeding on klu flowers but not on pods. When disturbed while feeding or ovipositing, adults usually dropped to the ground and frequently went into a state of thanatosis ("death mimicry") which sometimes lasted as long as 2 minutes, but more often ended after 10 to 30 seconds. During thanatosis, the beetle lay on its dorsum with legs and antennae held close to the body. When the state was terminated, either with or without an external stimulus, the beetle righted itself with a hind leg. Subsequent disturbance was more apt to produce flight than renewed "death feigning".

Competitors

Klu pods, at various stages in their development or disintegration, were found to be occupied by many different insects, mites and other organisms. Some were general scavengers or saprophytes, however, and only those organisms, including fungi, which subsisted on intact klu seeds were defined as "competitors".

M. sallaei and its competitors damaged most of the seeds in 510 pods collected at various locations on leeward Oahu during the period from August 1958 to January 1960. The pods contained a total of 7668 seeds: 27.2 per cent apparently undamaged; 39.9 per cent destroyed by grubs of *M. sallaei*; and 32.9 per cent rendered unsuitable for the development of *M. sallaei* by the activity of competitors, principally fungi.

Dr. H. Shirakawa, a mycologist with the U. S. Department of Agriculture Plant Quarantine Division, identified the fungus damaging klu seeds as *Aspergillus* sp. It developed readily within green klu pods and, under wet conditions, continued to grow in brown pods. Seeds upon which *Aspergillus* was growing first exhibited characteristically crinkled ridges in their seed coats and later were covered by a white mycelial mass. In the final stages of fungal development, infected pods were frequently filled with black, powdery sporangia. The pods turned brown prematurely but often remained on the bush for months.

Although it was shown that *M. sallaei* could become contaminated with *Aspergillus* spores during the process of emerging from an infected pod, its feeding and oviposition habits made it an unlikely vector. Infection might have occurred when *M. sallaei* oviposited within a spine wound on a green pod, but usually the bruchid laid its eggs on the surface of brown pods. However, an anthribid, *Araecerus levipennis* Jordan, readily attacked green klu pods even though this host was unsuitable for its development. Furthermore, females of *A. levipennis* collected in the field were found to be contaminated with *Aspergillus* and rotten pods usually had the punctures, distortions, and resin globules characteristic of *A. levipennis* oviposition sites. *A. levipennis* may not be a specific vector of *Aspergillus*, but its attacks apparently increase the chances of fungal infection in klu pods.

Two moths, a pyralid, *Ectomyelois ceratoniae* (Zeller), and an olethreutid, *Cryptophlebia illepida* (Butler), also developed in klu pods. A cerambycid beetle, *Sybra alternans* Wiedemann, was sometimes found in brown pods and, although its larvae did most of their feeding on the pod itself, they sometimes also chewed on the seed coats. Active grubs of the anobiid, *Catorama herbarium* Gorham, usually were found in seeds already damaged by other larvae but occasionally penetrated those previously unattacked. Two bruchids other than *M. sallaei* have sometimes been reared from klu. These were *M. amicus* and *C. gonagra*. Swezey (1931) reported that 37 "ripe" klu pods collected on Maui in August, 1929, yielded 133 *M. sallaei* and 1 *M. amicus*. Swezey (1938) also presented a note on rearings from klu pods gathered at Makapu, Oahu which included 174 *M. sallaei* and 3 *M. amicus*. During the spring of 1959, 68 pods exposed for varying periods at Diamond Head, Oahu, produced 175 *M. sallaei*, 1 *M. amicus* and 1 *C. gonagra*. Furthermore, 623 pods, most of them more than four months old, collected at various locations around Honolulu during the period from August to December, 1959, yielded 572 *M. sallaei*, 11 *C. gonagra* and 1 *M. amicus*.

Mortality

Egg: Both field and laboratory observations suggested that many eggs of *M. sallaei* were removed from klu pods by ants such as *Monomorium* sp. Even more eggs were killed, possibly by high temperature or excessive desiccation, under exposed conditions.

M. sallaei eggs were sometimes parasitized by a trichogrammatid wasp, *Uscana semifumipennis* Girault, which also attacks the eggs of at least six other bruchids in Hawaii. This may be the "very minute chalcid" reared in Texas by Cushman (1911) from "huisache" (klu) pods infested by *M. sallaei*. Bridwell (1920) was the first to record *Uscana* from *M. sallaei* in Hawaii and observed that attacks were "confined to the recently laid (unincubated) eggs". Bionomic studies of the wasp conducted during October, 1958, showed that eggs three days old could be parasitized, but those which had developed five days were no longer susceptible. The wasps pupated about one week after attack, at which time the chorion of the host eggs darkened, although less conspicuously than lepidopterous eggs parasitized by *Trichogramma* sp. *Uscana* required from 13 to 19 (average 15) days to complete its development. One *Uscana* adult, approximately 0.8 mm. long, emerged from each egg, chewing through the chorion and leaving a hole about 0.3 mm. in diameter.

The removal of egg shells by ants and rain made it quite difficult to estimate the effectiveness of *Uscana*. However, 80 klu pods were collected during February and March, 1960, at Diamond Head. Remaining on the pods were 470 eggs: 10.8 per cent parasitized, 19.7 per cent hatched and 69.4 per cent killed by other factors.

Larva: Some larvae hatching from those eggs which have not been eaten, parasitized or killed by other factors died before they penetrated the pod. Others drowned in the exudations of green pods or starved in the nutritionally unsuitable seeds of moldy pods. Larvae surviving these hazards could be parasitized by any one of the following six wasps: the braconids, *Urosigalphus bruchi* Crawford, *Glyptocolastes bruchivorus* Crawford, and *Heterospilus prosopidis* Viereck; a pteromalid, *Lariophagus texanus* Crawford; a eupelmid, *Eupelmus cushmani* (Crawford); or a eulophid, *Horismenus* sp.

Shipments of *Heterospilus* (and possibly *Uscana*) were made from Texas to Hawaii in 1910 (Williams, 1931:370). In 1921, the other parasites were introduced from Texas (Fullaway, 1921) although *Eupelmus* was not established until its introduction from Guatemala in 1934 (Swezey, 1938). These larval parasites had been reared "in considerable numbers" from *M. sallaei* in Texas by Cushman (1911).

Parasitization of *M. sallaei* in Hawaii was first recorded in the following notes: *Lariophagus* (Willard, 1922); *Glyptocolastes* (Bissell, 1923); *Heterospilus* (Swezey, 1924); *Horismenus* (Willard, 1924); *Urosigalphus* (Lutken, 1925); and *Eupelmus* (Swezey, 1938). They (and *Uscana*) are now well distributed, attacking *M. sallaei* throughout the Islands.

Rearings and dissections in the present study, generally using material collected in the field, made possible some observations on the bionomics and effectiveness of these wasps. All three of the braconids apparently are solitary internal parasites of bruchid larvae. The types of legumes in which their hosts were developing seemed to influence the relative abundance of these wasps.

Heterospilus was rarely reared from bruchids in klu although it was the most common parasite obtained from those in kiawe. *Urosigalphus* was the most common braconid on klu in Hawaii (and Texas) and on kiawe it was almost as common as *Heterospilus*. *Glyptocolastes* was usually less common than *Urosigalphus* on both klu and kiawe. When these braconids parasitized *M. sallaei* in Hawaii, their development took from 3 to 7 weeks. *Urosigalphus*, however, took much longer to develop when it parasitized the slow-growing grubs of *C. gonagra*. In one case, this braconid required at least 10 weeks to complete its development on *C. gonagra*, suggesting that it pupates no sooner than the pre-pupal stage of its host. *Glyptocolastes* and *Heterospilus* may not have such close synchronization with their hosts since undersized adults (2 to 3 mm.) were frequently observed. The normal size for braconid adults of all three species was from 4 to 5 mm. During the process of emergence, they chewed capless exit holes about 1 mm. in diameter. These holes and the remains of cocoons within seeds were useful indicators of braconid parasitization.

The adult braconids reared from klu could be distinguished by color characteristics. *Urosigalphus* has a deeply sculptured and uniformly black body, *Glyptocolastes* has black areas on its dark red body, and *Heterospilus* is usually uniformly reddish-yellow. Another distinction which is sometimes useful in identifying darker males of the latter species is the presence of conspicuous stigmata on the hind wings.

Adult female *Urosigalphus* and *Glyptocolastes* were often observed in the field parasitizing grubs within green or brown klu pods, but rarely attacked grubs within brown seeds under laboratory conditions. Counts of exit holes in 3,066 seeds collected on leeward Oahu during 1958 and 1959 suggested that the total parasitaization of *M. sallaei* by *Urosigalphus* and *Glyptocolastes* was approximately 31 per cent. In Hawaii, *Urosigalphus* apparently parasitizes not only the four bruchids infesting kiawe, *A. prosopis*, *M. amicus*, *M. sallaei* and *C. gonagra*, but also *Callosobruchus chinensis*. Hosts of *Glyptocolastes* include, in addition to the kiawe bruchids, *Stator limbatus* and *C. chinensis*. *Heterospilus*, incidentally, has been reared from three bruchids other than those it attacks in kiawe: *Bruchus phaseoli*, *Stator pruininus* and *C. chinensis*. Extensive rearings from various legumes would presumably show that other bruchids in Hawaii are suitable hosts for one or more of the braconids.

The eulophid, *Horismenus* sp. (which apparently is not yet described), seldom parasitizes bruchids other than *M. sallaei*. It is a small (2 mm.), gregarious, and presumably internal parasite. Its development, under Hawaiian conditions, usually took from 4 to 7 weeks, sometimes longer. After casting their thick, black pupal exuvia, the metallic black adults emerged from a single hole in the seed. The number coming from a seed ranged from 6 to 36 and averaged about 16. The sex ratio was approximately 3 females to 1 male in most lots.

The pteromalid, *Lariophagus*, is another small (2 to 3 mm.), gregarious, but presumably external parasite. Unlike the other larval parasites of *M. sallaei*, it

readily parasitized *M. sallaei* grubs (and possibly pupae) in brown klu seeds under laboratory conditions, developing in 3 or 4 weeks. From 3 to 10 *Lariophagus* adults emerged from each seed, the average number being 8. The sex ratio was generally about 4 females to 1 male. Hawaiian and North American host records suggest that *Lariophagus* can parasitize at least three bruchids other than *M. sallaei*: *A. prosopis*, *S. pruininus* and *Callosobruchus maculatus*.

The two small larval parasites can be distinguished easily. The adult *Lariophagus* has darker femora and is usually larger than *Horismenus*. Also, a *Lariophagus* female has a more pointed abdomen and a longer ovipositor. Counts of exit holes in klu seeds collected on leeward Oahu during 1958 and 1959 suggested that the combined parasitization of *M. sallaei* by *Horismenus* and *Lariophagus* was about 17 per cent.

A very interesting, but even less important, source of mortality was *Eupelmus cushmani*. This eupelmid wasp has an unusually wide host range. In Hawaii, it not only attacks anthribids, bruchids and curculionids but also has been reared from larvae of the wasp, *Bracon terryi* (Bridwell), and the fly, *Procecidochares utilis* Stone (Bess and Haramoto, 1959), as well as pupae of a coleophorid moth, *Agonoxena argaula* Meyrick, and (? hymenoptera in) mantid eggs (Weber, 1957).

Eupelmus develops as a solitary external parasite and spins no cocoon. Length of development seemed to be quite variable but may have been as short as 3 weeks when the larvae were feeding on grubs of *M. sallaei*. In dissections, the fuscous pupal fragments of *Eupelmus* were found within braconid cocoons, confirming the hyperparasitic habit noted by Bess and Haramoto (1959). The eupelmid also attacked *M. sallaei* pupae, sometimes unsuccessfully. The large (6 mm.) female could be separated from other members of the parasite complex by its elongate form and white-ringed ovipositor. The smaller (2 to 3 mm.) male might have sometimes been confused with *Horismenus* but could usually be identified by the greater length of its antennae and the metallic green coloration of its body. Rearings from klu pods collected in the vicinity of Honolulu during 1958 and 1959 indicated that parasitization of *M. sallaei* by *Eupelmus* was usually less than 0.5 per cent.

It has already been noted that the destruction of klu seeds by competitors often led to the starvation of early instar *M. sallaei* grubs. Occasionally, however, competitive mortality was more direct. A lepidopterous larva within the same pod or another grub within the same seed sometimes came in contact with a *M. sallaei* grub, wounding it fatally. There was no evidence of "combat" or "cannibalism".

Adult: Teneral adults of *M. sallaei* were occasionally parasitized by the mite, *Pyemotes boylei* Krczal. This is the species that attacks all stages of *A. levipennis* and which was recorded as "*Pyemotes* (=*Pediculoides*) *ventricosus* (Newport)" by Sherman and Tamashiro (1956). The pyemotid female usually entered a klu seed through the crack made by a bruchid chewing out an exit in the seed coat. It developed as a sedentary ectoparasite, paralyzing the beetle and becoming en-

gorged. After a developmental period lasting about one week, a few male and more than a hundred female nymphs usually emerged from the abdomen of each gravid mite.

Adults of *M. sallaei* undoubtedly succumbed to the attack of various predators, although this was hard to observe in the field. The reduviid bug, *Zelus renardii* Kolenati, a known bruchid eater, was sometimes seen on klu bushes. Webs of spiders such as *Argiope* sp. and ootheca of mantids, *Tenodera* sp., were observed frequently. Finally, *M. sallaei* has been recovered from the crop of a California Quail in Hawaii (Swezey, 1937) although this may have been incidental to quails feeding on klu seeds.

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External Sex Characteristics of Cryptotermes brevis (Walker) and Kalotermes immigrans Snyder (Isoptera: Kalotermitidae)

ELIZABETH A. MCMAHAN

DEPARTMENT OF ZOOLOGY AND ENTOMOLOGY
UNIVERSITY OF HAWAII
HONOLULU, HAWAII

(*Submitted for publication November, 1959*)

The external characteristics used in distinguishing sex in termites concern primarily the terminal three or four abdominal sterna and their appendages. The presence or apparent absence of these structures, however, and their variations depend upon the species involved. Imms (1920) has described in detail the external sex morphology of *Archotermopsis wroughtoni* Desneux for all castes, and Sumner (1933) has studied similarly *Zootermopsis angusticollis* Hagen. Their descriptions form the basis for this brief discussion of means of sex identification in *Cryptotermes brevis* (Walker) and *Kalotermes immigrans* Snyder.

A typical termite has ten abdominal terga and nine sterna (the first sternum is atrophied). Sub-anal styles are often present on the posterior margin of the ninth sternum, and anal cerci are always present, arising from beneath the tenth tergum. Figure 1, A is a lateral view of the abdomen of a *Cryptotermes* male primary reproductive, showing the typical arrangement of terga, sterna, sub-anal styles, and cerci.

Reproductives. In *C. brevis* the primary reproductives show morphologically the same general characteristics that Imms and Sumner describe for *Archotermopsis* and *Zootermopsis* respectively, and the sexes are easily distinguished. Sterna 2–9 are simple plates in the male, and sternum 10 is divided into two podical or sub-anal plates. Sub-anal styles are present. The female appears to possess a total of only seven sterna because the eighth and ninth are hidden by the much-enlarged seventh. The tenth is divided as in the male. Sub-anal styles are not present. Figure 1, B and C are ventral views of the abdominal apices of the male and female primary reproductives.

Supplementary reproductives have these same distinguishing characteristics, as have also the penultimate instars.

Soldiers. The easiest means of distinguishing male from female soldiers in *C. brevis* is by noting the presence or absence of sub-anal styles. Males have them; females do not.

Imms quotes Holmgren to the effect that external manifestation of sex in termite soldiers is to be found only for those of *Mastotermes* (Mastotermitidae).

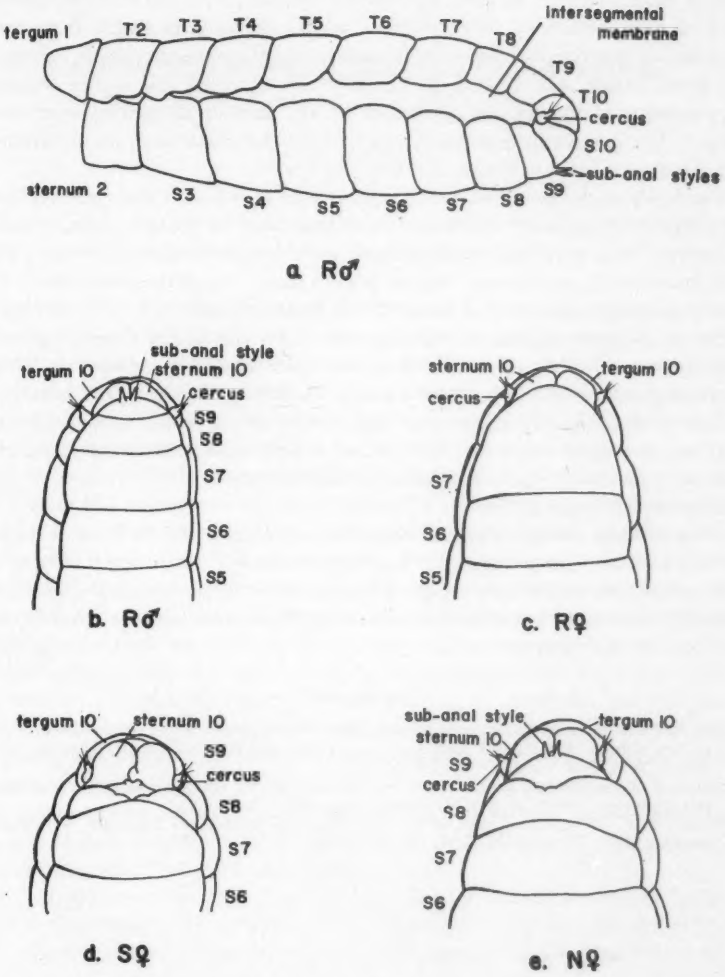

FIG. 1. A, Lateral aspect of abdomen of *Cryptotermes brevis* male primary reproductive; B, C, D, E, ventral aspects of apices of abdomens of *C. brevis* male primary reproductive, female primary reproductive, female soldier, and female nymph, respectively.

Imms points out, however, that *Archotermopsis* (Hodotermitidae) and certain genera of the Kalotermitidae similarly exhibit it. Müller (1873), for example, showed that female soldiers of two *Kalotermes* species are distinguishable from male soldiers by the shape of sternum 8, females having the posterior margin indented. *C. brevis* female soldiers may be similarly distinguished, the eighth sternum appearing as two lateral plates posterior to, and partially covered by, sternum 7 (fig. 1, D). The characteristic notching of the eighth sternum in the female will be mentioned again in connection with the nymphs.

Nymphs. Up to this point sex in *C. brevis* has been shown to be distinguishable on the basis of the presence or absence of sub-anal styles. In the case of the nymphs, however, this is not a basis for differentiation. Both male and female nymphs, with the exception of penultimate females, possess them. The differences come in the posterior marginal contour of sternum 8. In female nymphs (fig. 1, E) the eighth sternum is posteriorly notched to a greater or a lesser degree depending upon the instar, and with every molt becomes more and more overgrown by an enlarging sternum 7, under which it can be telescoped. Older females have only a lobe of the eighth visible on each side, similar to the female soldier. In male nymphs the eighth sternum is simple and straight along the posterior margin, just as in the case of male primaries and male soldiers.

Kalotermes immigrans Snyder

The sexually distinguishing characteristics discussed for *C. brevis* will also differentiate between the sexes for *K. immigrans*, except that in the soldier, as in the nymph, sub-anal styles are present in both sexes. In this case the notching of the eighth sternum, its partial concealment by the seventh, and the broad nature of the latter identifies the female.

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The Hawaiian Entomological Society: An Analysis of Its Growth and Activities[1]

TOSHIYUKI NISHIDA[2]

HAWAII AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF HAWAII
HONOLULU, HAWAII

(*Presidential Address, submitted December, 1959*)

Periodic analysis of the activities of the Hawaiian Entomological Society, even if it serves no other purpose other than to stimulate interest in its affairs, is well worth the effort and pages devoted to it in the "PROCEEDINGS". Such analysis, if it is to be of value, must be as frank and objective as possible. Furthermore, such an undertaking should be made at least every five years so that we may be able to detect our progress as well as the shortcomings of our Society.

At the close of this last meeting of 1959 I would like to present an analysis of the growth and activities of the Society from the time of its organization to the present. I can assure you that this was not done because I felt that something was wrong with our Society. I do feel, however, that no society is perfect, and that we should strive for improvement in order to be of greatest service to our profession and to fulfill our obligations to our community. I hope that, besides fulfilling my obligations as the retiring president, the present discussion may be of interest historically as well as in turning our thoughts to the improvement of our Society. It is not the intent of this discussion to cover all aspects of our Society's activities. It is my hope that others coming after me will express their own viewpoints, which may not be in agreement with mine, and also touch upon those subjects that I have omitted. Various aspects pertaining to our Society have been discussed already by my predecessors and one may find material for thought in their comments (Ehrhorn, 1913; Muir, 1914; Giffard, 1920; Bryan, 1929; Pemberton, 1934, 1951; and Schmidt, 1939).

Historically, the Hawaiian Entomological Society has an interesting background. Fifty-three years have passed since that memorable day, December 15, 1904, when a group of eight far-sighted individuals met in the board room of

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[1] Published with the approval of the Director of the Hawaii Agricultural Experiment Station as Miscellaneous Paper No. 118.

[2] I wish to extend my apologies for serving the Society for such a short period before my departure to India, and thank all elected and appointed officers for the fine cooperation which they have given me during my term of office. This manuscript was completed in India during the tenure of a research scholarship from the United States Educational Foundation. The time and material made available by the Foundation are gratefully acknowledged.

the Bureau of Agriculture, now the State Department of Agriculture and Conservation, "to consider the advisability of forming the Hawaiian Entomological Society." The purpose of the proposed organization was to "promote the study of entomology in all possible bearings, and to encourage friendly relations between those in any way interested in the science." Since then the Society has met at monthly intervals for the past fifty-three years or nearly 650 times. There is no doubt that our Society, although relatively small, has been of immeasurable value in fostering friendly relations among entomologists, encouraging the study of insects, and rendering valuable service to our island community in regards to a multitude of entomological problems (Pemberton 1951).

Membership Growth and Attendance

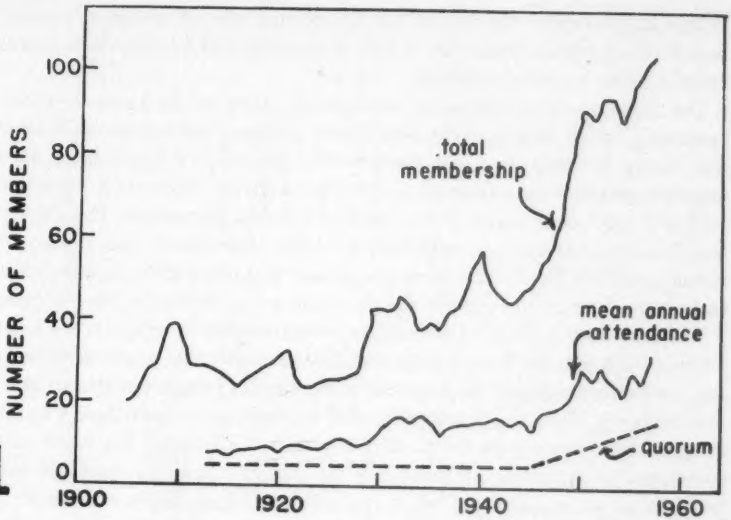
The membership of the Society at present consists largely of entomologists employed by various agencies in Hawaii: Bernice Pauahi Bishop Museum, Federal Quarantine Service, United States Agricultural Research Service, United States Public Health Service, State Board of Health, State Department of Agriculture and Conservation, Pineapple Research Institute of Hawaii, Hawaiian Sugar Planters' Association, and the University of Hawaii. It is indeed gratifying that practically all entomologists employed by these agencies, as well as graduate students in Entomology at the University of Hawaii, are members of the Society. In addition, we have a number of members residing outside of Hawaii who are interested in the entomology of the Pacific area.

The nucleus of the Society was a small group in 1905; however, today we have a sizeable membership in spite of the small geographical area of Hawaii. The growth of the Society, as shown in figure 1, was slow at the beginning but within the past ten years has increased rapidly. The growth curve shows no indication of leveling off within the next few years. Interestingly, the growth curve is similar to the well-known logistic curve familiar to demographers and population ecologists. Such a growth obvioulsy has nothing to do with the reproductive rate of entomologists for entomologists do not always beget entomologists. It is likely that such growth indicates that as the human population and general economy of Hawaii has increased the need for entomologists has incerased proportionally.

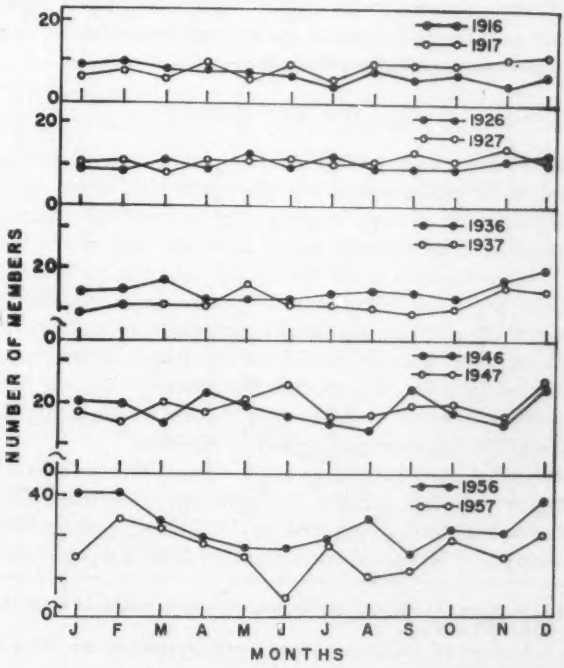
The attendance data shown in figure 1 are somewhat of a disappointment. It is evident that throughout the years the attendance has been considerably below the maximum which is possible even after allowance is made for non-resident members. To be sure, we can never hope to have a perfect attendance as there will always be members who are either on sabbatical leave or conducting research in various parts of the world. Even though the attendance has not been as good

Figure 1. The growth in total membership and mean annual attendance of the Hawaiian Entomological Society from 1905 to 1957.

Figure 2. Monthly variation in the number of members attending meetings of the Hawaiian Entomological Society during various years.


NUMBER OF MEMBERS
100
80
60
40
20
0
1900
1920
1940
1960
total membership
mean annual attendance
quorum

1


NUMBER OF MEMBERS
1916
1917
1926
1927
1936
1937
1946
1947
1956
1957
20
0
40
J F M A M J J A S O N D
MONTHS

2

as one might desire, the Society has always had enough members present to constitute a quorum. From 1905 to 1945 the quorum was five members; however, in 1945 it was increased to fifteen.

The seasonal characteristics of attendance, presented in figure 2, show an interesting trend. Although the data for all years are not presented, it appears that during the early years, for example 1916 and 1917, the attendance did not fluctuate greatly from month to month. However, in recent years, for example 1956 and 1957, there seems to be a marked seasonal fluctuation. The December and January meetings generally have a higher attendance than those of the summer months. From these records it appears that members took more consistently active interest throughout the year during the early years than at present.

The cause of the declining attendance of our monthly meetings is not known; however, this year the Society made an effort to correct this situation. It was felt that the strengthening of the programs of the meetings might result in an increase in attendance. Thus, the Society amended its constitution to include a standing Program Committee with Dr. C. E. Pemberton as chairman. The effect of this committee in increasing attendance is not as yet known. In addition to the program an active participation in the presentation of notes, exhibitions and discussions by all members would no doubt have a beneficial effect on attendance. It seems to me that with the retirement from the Society of such members as Dr. Swezey and Dr. Williams our Society has lost much of that flavor that formerly made our meetings so interesting.

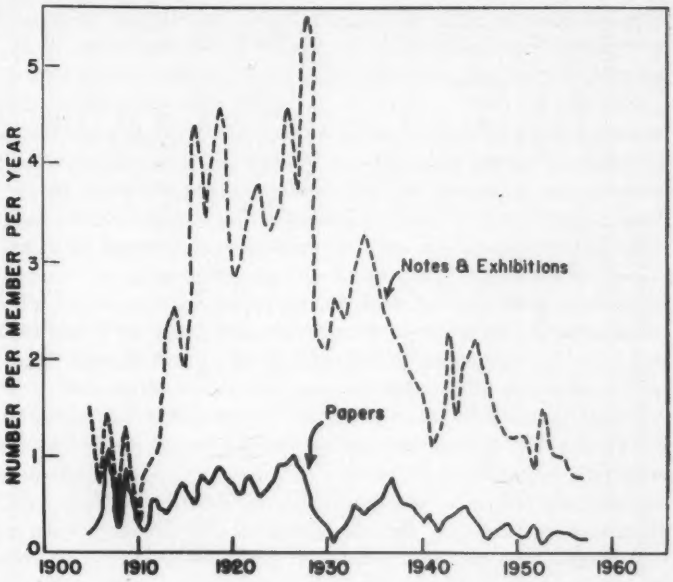
The "Proceedings"

One of the major undertakings and also perhaps one of the major assets of the Society is the publication of the "Proceedings", which up to 1958, have been published in 16 volumes. In going over these volumes one cannot help but be impressed by their contents, and at the same time cannot help but being thankful that the founders of our Society had the vision to foresee that the time would come when the "Proceedings" would be a valuable storehouse of entomological information. Incidentally, it might be of interest to point out that our "Proceedings" antedate two of the best known American entomological periodicals, the Journal of Economic Entomology and the Annals of the Entomological Society of America, published by the largest entomological organization, The Entomological Society of America.

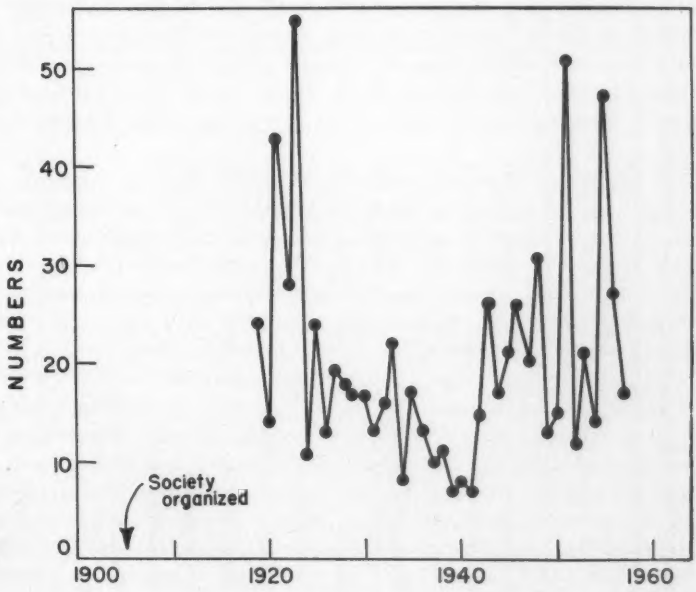
The content of our "Proceedings" is unique. To my knowledge no other entomological periodical contains the same type of material. The contents of the "Proceedings" may be grouped into the following categories: (1) Minutes of the meetings, (2) Notes and exhibitions, (3) Technical papers, and (4) Miscel-

Figure 3. Number of notes and exhibitions, and papers published in the "Proceedings" each year from 1905 to 1957.

Figure 4. Number of chance immigrant insects reported in the "Proceedings" each year from 1919 to 1957.


NUMBER PER MEMBER PER YEAR
0
1
2
3
4
5
1900
1910
1920
1930
1940
1950
1960
Notes & Exhibitions
Papers

3


NUMBERS
0
10
20
30
40
50
1900
1920
1940
1960
Society organized

4

TABLE 1. Numbers of papers in the various entomological fields published in the "PROCEEDINGS" from 1905 to 1957.

Subject Category	1905–1910		1911–1920		1921–1930		1931–1940		1941–1950		1951–1957	
	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
Taxonomy	51	52.6	90	55.2	104	53.6	122	56.2	102	57.9	81	55.1
Biological Control	0	0.0	4	2.4	7	3.6	4	1.8	11	6.2	16	10.9
Insect Pathology	0	0.0	2	1.2	0	0.0	0	0.0	0	0.0	6	4.1
Transmission of Plant Diseases	0	0.0	0	0.0	0	0.0	2	0.9	1	0.6	0	0.0
Ecology	0	0.0	1	0.6	0	0.0	3	1.4	1	0.6	4	2.7
Morphology	0	0.0	1	0.6	1	0.5	0	0.0	2	1.1	3	2.0
Economic Entomology	2	2.1	3	1.8	14	7.2	12	5.5	13	7.4	3	2.0
General Biology	38	39.2	45	27.6	42	21.6	32	14.7	21	11.9	20	13.6
Zoogeography	3	3.1	0	0.0	5	2.6	4	1.8	1	0.6	0	0.0
Medical and Veterinary	0	0.0	2	1.2	4	2.1	8	3.7	7	4.0	1	0.7
Miscellaneous (addresses, obituaries, letters, by-laws, resolutions, etc.)	3	3.1	15	9.2	17	8.8	30	13.8	17	9.6	13	8.8
Total	97		163		194		217		176		147	

laneous (obituaries, book reviews, letters, resolutions, etc.). In some instances, especially in the early issues, it is difficult to classify the contents strictly in accordance with these categories; nevertheless, it is felt that such a grouping may be useful in the present discussion.

Both the number of notes and exhibitions and the number of papers published in the "PROCEEDINGS" show a trend that is disturbing (figure 3). Although tabulated, the number of minutes and miscellaneous material is not shown in figure 3 because these items are not of great importance from a scientific standpoint. It is evident from the data presented that the number of notes and exhibitions presented was highest during 1916 to 1926 and, thereafter, we note a consistent decline. The number of papers published does not show as marked a fluctuation as that of the notes and exhibitions; however, it also shows a similar declining trend. This decline cannot be attributed to the decrease in the number of short papers because the number of pages per volume also showed a decline. To a certain extent this decline may be attributed to the reluctance of members to publish papers in the "PROCEEDINGS" because of a feeling among some that little or no prestige is gained by doing so. I do not intend to argue whether or not our "PROCEEDINGS" have or do not have this nebulous but much sought after commodity. However, it is difficult to see how a journal can ever attain prestige when its members are willing to receive it, but are unwilling to contribute to it. Needless to say, the *sine qua non* of attaining this commodity lies in the members themselves. In addition, it might be said that this decline could also be due to the cost of the reprints. Admittedly the cost of our reprints as compared to others has been high; however, the organizations with entomologists on their staff have been exceedingly generous in giving us financial support and in purchasing reprints of papers published by their staff members in spite of the cost.

The proportion of pages of the "PROCEEDINGS" devoted to the above-mentioned categories may be of interest, particularly to the Editorial and Finance Committees. As indicated in figure 5, the proportion of pages devoted to the various categories remained remarkably constant throughout the years in spite of the changes in size of the volumes. The approximate percentages were: (1) papers, 80 per cent; (2) notes and exhibitions 10 to 15 per cent; and (3) minutes and miscellaneous materials each 2 to 5 per cent. Thus, we see a good distribution of pages in the various categories.

An attempt was made to determine the different kinds of papers published in the "PROCEEDINGS", even though the classification is at best arbitrary as some papers contained subjects covering several fields. The kinds of papers published covered the following fields: taxonomy, biological control, insect pathology, disease transmission by insects, ecology, morphology, economic entomology, general biology, zoogeography, and medical and veterinary entomology. Papers on taxonomy and general biology represented the highest percentage of papers (Table 1). It was of interest to find that the number of different kinds of papers

increased between 1905 and 1930, however, since then there has been no increase (figure 6).

One of the chief activities of the Society is the recording of new immigrant insects in the "PROCEEDINGS" as they are discovered in Hawaii (Pemberton, 1951). The number of immigrant insects recorded during 1919 to 1957, shown in figure 4, indicates that new insects have been detected here every year since 1920. These figures are in agreement with the statement made by Jensen (1946) that despite the most diligent quarantine inspection, foreign insects are still being introduced, but that the quarantine service reduces the number of these introductions to a fraction of what it would be in the absence of their work.

In regard to our "PROCEEDINGS" I feel that improvements are in order. We have increased the price but the contents have been declining in recent years. Does this mean that we are exhausting our entomological work in Hawaii? My answer to this question is an unqualified no. There are still vast unexplored areas of entomological research in Hawaii, and the "PROCEEDINGS" should continue to be a valuable depository of information on Hawaiian entomology. Furthermore, we should strive to publish papers of greater diversity than in the past. By doing so we might increase the value and circulation of our journal thus alleviating some of our perpetual financial problems.

VISITORS TO OUR SOCIETY

Among the important assets of the Society is the attraction of visitors to our meetings (Pemberton, 1951). Geographically isolated as we are from other entomological laboratories and societies, it is highly important that we receive visitors so that there can be free interchange of ideas, thus making it possible to keep in touch with new developments in the various entomological fields. It is not possible to list all those who have visited us, but it can be said without reservation that we have been visited by many of the leading entomologists of the world. The number of visitors attending our meetings has increased considerably during recent years. (figure 7), and it is my hope that we will continue to welcome increasing numbers of visitors in the years to come.

CONSTITUTION AND BY-LAWS

The first meeting to organize the Hawaiian Entomological Society was held December 15, 1904. With eight members present, the organization of the proposed Society was thoroughly discussed and Messrs. Craw, Kotinsky and Terry

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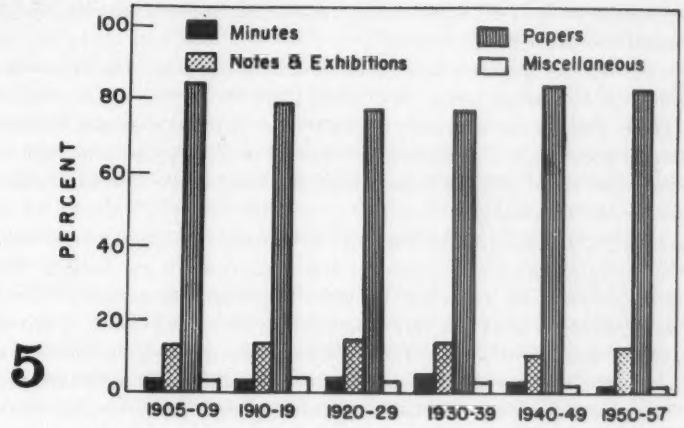
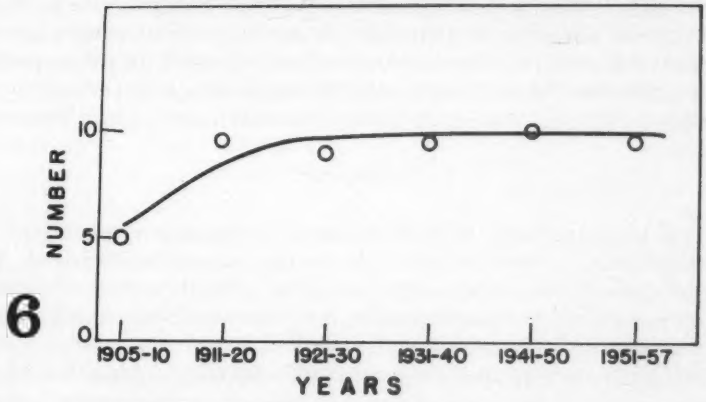
Figure 5. Percentage of pages of the "PROCEEDINGS" devoted to various categories published, exclusive of the indices.

Figure 6. Changes in the number of papers in the various entomological fields published in the "PROCEEDINGS" from 1905 to 1957.

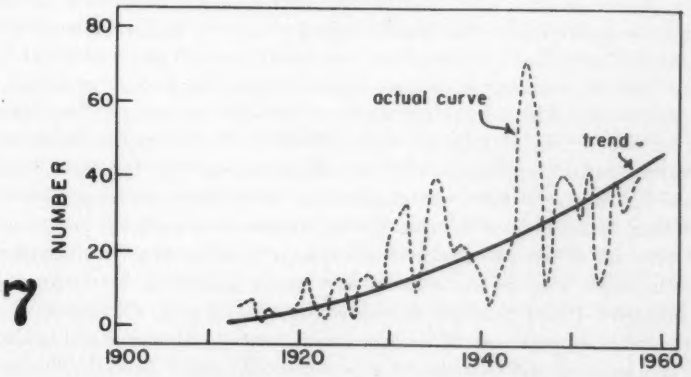
Figure 7. Number of visitors that attended the meetings of the Hawaiian Entomological Society from 1913 to 1957. Records before 1913 are not available.


Minutes
Notes & Exhibitions
Papers
Miscellaneous
PERCENT
100
80
60
40
20
0
1905-09
1910-19
1920-29
1930-39
1940-49
1950-57

5


NUMBER
10
5
0
1905-10
1911-20
1921-30
1931-40
1941-50
1951-57
YEARS

6


NUMBER
80
60
40
20
0
actual curve
trend
1900
1920
1940
1960

7

were appointed to draft the constitution. At the meeting held January 26, 1905 the original constitution was adopted.

In going over the records I have found that the constitution has been revised or amended at least seven times, 1906, 1909, 1919, 1931, 1933, 1938, 1956, and 1958. These changes are a healthy sign for they indicate that our Society is changing in response to the needs of a changing world. At the same time it is a distinct credit to the original founders that the basic structure of the constitution has remained unchanged.

There is another comment that I would like to make in regard to the constitution which might have a bearing on the future activities of our Society. Upon reading the constitution, I was puzzled with the phrase: "to encourage friendly relations between those in any way interested in the science . . .". I thought such a phrase was redundant for it implied that there were hostile relations and that one of the objectives of the Society was to bring about harmonious relationships. There are no such hostile relations. However, I can now see the significance of that phrase. With the growth of our Society and our community the problems that confront us tend to be more numerous and complex than in the past, and internal conflicts and misunderstandings are likely to arise. I sincerely hope that such conflicts never arise and that the day will never come when professional entomologists will need a written code of ethics such as those of certain other professions.

Finance

As in the case of other scientific societies, our Society has been beset with financial difficulties even though we do not have any outstanding debts. The major expenses of the Society are (1) cost of the publication of the "Proceedings" and indices, (2) contributions to the Zoological Record and Hawaii Science Fair, and (3) general operating expenses.

The Society is a non-profit but not a self supporting organization, whose income is derived from dues, sale of the "Proceedings", and contributions. Aside from contributions our largest source of income is from dues, which, incidentally, have been five dollars per year for the past 53 years. Although our income from this source has shown marked increase in recent years due to increased membership, the Society has never been self supporting. The income from the sale of the "Proceedings" has not been of such magnitude as to be of great financial help. The price of the "Proceedings" in 1905 was 50 cents per number; later, the price was increased to two dollars, and at present it is five dollars. In addition to these sources of income the Society has been indeed very fortunate in having support from various sources. The Trustees of the Hawaiian Sugar Planters' Association have given generously for many years. The McInerny Foundation has also given financial support. Others who have contributed in the past were: W. G. Irwin and Company; Alexander and Baldwin, Ltd.; H. Hackfield and Company; Castle and Cooke, Inc.; Theo. H. Davies &

Co., Ltd.; C. Brewer and Company, Ltd.; Schaefer and Company; and Bishop and Company. In addition to these contributors, the society has been blessed with the generosity of other organizations that have given generous support through the purchase of reprints of papers published in the "PROCEEDINGS" by members of their respective organizations. At one time we had "Patrons" in our Society who were not professional entomologists but who gave financial assistance (Muir, 1914). Although others have expressed it in the past, I personally wish to take this opportunity to extend the Society's thanks to all those supporters without whose generosity the Society could not have possibly existed for 53 years.

It is evident to all members that the financial status of our Society has never been very sound. Even though our income has increased considerably because of increased membership, the cost of operating the Society has also increased and thus we have to depend on contributions. I personally feel that our Society should make every effort to be self supporting even though it means an increase in the dues. It might be argued that increasing the dues accomplishes nothing because it might result in a decrease in membership. I cannot share this viewpoint because nearly all other scientific Societies have increased their dues in recent years without any apparent adverse effect on membership. Members who are not interested in the Society will drop out whether or not we keep the dues at the 1905 level.

CONCLUSION

The purpose of this discussion has been to make an analysis of the Society's past performance. Through such an analysis it is hoped that we can prepare for future development of our Society. Although several possible improvements are suggested in this discussion, it is with considerable pride that I can state that the Society has done remarkably well considering the resources available. It is my sincere hope that our Society will continue to operate in as creditable a manner as it has done in the past.

In closing I would like to dwell on a thought which has come to me from my hobby of breeding dogs of exhibition quality which might have a bearing on this discussion. Not long ago I had an opportunity to discuss problems of dog breeding with some of the outstanding authorities in the field. I remember vividly a statement made by one of these men that the most dangerous obstacle to the improvement of any breed is a disease called "kennel blindness", a disease, which to my surprise, is one which affects the eyes of man and not of dogs. The typical syndrome is inability to see the weaknesses and faults of one's own dogs and the superior ability to see the short-comings of others. There seems nothing dreadful about this disease as far as one's health is concerned; but it has an adverse effect on one's own breeding program by creating a feeling of complacency, a feeling (in spite of what the doctors say about a person's heart) that is not the very best intellectual milieu for improvement.

I hope that our members never suffer from "kennel blindness". The Hawaiian economy is growing. The attainment of statehood, growth of industrial and agricultural enterprises, and the approaching jet age, are but a few significant omens of that future growth. In such a dynamic era as this, where problems become increasingly numerous and complex, our Society cannot afford to be static. It must keep up with the tempo of our present era in order to be an asset rather than a liability both to our profession and our community.

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Bulbostethus chrysopterus (Herrich-Schäffer), an Old Bug with a New Name (Heteroptera: Pentatomidae)

HERBERT RUCKES[1]

AMERICAN MUSEUM OF NATURAL HISTORY
NEW YORK

(*Submitted for publication May, 1959*)

Herrich-Schaffer (1844) described and figured an asopine pentatomid under the name of *Asopus chrysopterus*. Since then the name, like the proverbial football, has been kicked back and forth across the field of hemipteran nomenclature. Lethierry and Severin (1893) first included it in the genus *Canthecona* Amyot and Serville; later Schouteden (1907), in his monograph on the Asopinae in the Genera Insectorum, asigned it, questionably, to a place under his newly erected genus *Canthoconidea* and Kirkaldy in his Catalogue (1909) accepted this disposition. But, shortly thereafter, Bergroth (1915) in analyzing Schouteden's work on *Canthoconidea*, and separating the latter's sections A and B into two distinct genera, *Canthoconidea* Schouteden and *Eocanthecona* Bergroth, pointed out that Herrich-Schaffer's species could not belong to either of these because it lacked the anteapical spines on the anterior femora, a prime requisite for both of the above, and suggested that a new generic name therefore be created. But Bergroth failed to erect such a name. Prior to this time, however, Schouteden (1907) had described an asopine from the Mariana Islands under the name of *Parealda bouvieri*, new genus, new species. Now, Usinger (1946) assigned *Asopus chrysopterus* Herrich-Schaffer to Schouteden's genus *Paraelda* and synonymized it with the latter's species *bouvieri* so that the new nomenclatural combination would have to read *Parealda chrysoptera* (Herrich-Schaffer). This appears to have been an error on Usinger's part. While Schouteden overlooked the aspinose condition of the anterior femora in *chrysopterus*, Usinger failed to consider, a. Herrich-Schaffer's description of the abdominal spine in his *Asopus chrysopterus* (" . . . der Bauch nach vorne sehr erhoben, der Dorn biz zu den Mittelbeinen reichend"), and b. Schouteden's specifications for the peculiar build of the mesosternum, metasternum, and abdomen of *Parealda* ("Mésosternum présentant de chaque côté du rostre une carène mince, moins élevées que celles du métasternum. Métasternum offrant de meme deux carènes, mais fortes, à tranche libre épaisse et lisse, se prolongeant librement en avant et en arrière entre les hanches . . . Ventre proeminent à la base et s'appuyant contre le métasternum.").

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[1] Research Associate, Department of Insects and Spiders, and Professor Emeritus, the City College of New York.

The implication here is that there is no long stout spine arising from the second abdominal segment that would reach between the mesocoxae as prescribed by Herrich-Schaffer.

All specimens, purported by Usinger to be *Parealda chrysoptera* (Herrich-Schaffer), were collected from Guam, Rota, Saipan, and Tinian in the Mariana Islands of Micronesia, and conform in all respects, both generic and specific, to Schouteden's description of *Parealda bouvieri*, but do not match the Herrich-Schaffer color plate (fig. 781) or his description of the species *Asopus chrysopterus*. The humeral spines are retrorsely curved and not elongated or directed anteriorly; the over-all color is darker reddish brown and not the required rusty yellow; the apical portion of the scutellum is eburnescent rather than concolorous; the abdominal spine is weak, short, and does not extend beyond the posterior margin of the metasternum, let alone being required to reach the mesocoxae, and the metasternum is strongly bicarinate, with a pronounced median sulcus between the carinae in which the distal segment of the rostrum lies. I feel certain that these specimens are definitely *Parealda bouvieri* Schouteden and should not be identified as *Parealda chrysoptera* (Herrich-Schaffer), despite Usinger's determination to the contrary.

In working over a collection of pentatomids received from the Bernice Bishop Museum in Honolulu, for the purpose of recording a faunal list of the Micronesian species of this family, a single female specimen has turned up that exactly meets every requisite set forth by Herrich-Schaffer for his *Asopus chrysopterus* and conforms to his colored plate. There are also eleven other specimens that, while slightly different in specific characters, agree with that single female specimen in the basic generic characteristics. I am convinced that this one specimen is the true *Asopus chrysopterus* of Herrich-Schaffer. It is quite distinct from specimens identified as *Parealda chrysoptera* (Herrich-Schaffer) by Usinger, Esaki, and Sailer. The body has the required shape, it is sordid yellow in color, overlain with reddish punctures producing a rusty aspect, the humeral processes are relatively long, and are directed anteriorly, becoming purplish brown apically, the anterior portion of the abdomen is well elevated and, in contour, continuous with the stout abdominal spine that reaches the mesocoxae and the anterior femora are aspinose. By the use of Schouteden's key for generic determinations (Genera Insectorum), this insect would run down to a place near *Podisus* Herrich-Schaffer. But there is at least one character which distinguishes this form from either *Podisus*, *Canthoconidea* or *Parealda*. That is the unique structure of the metasternum which here appears in the form of a small, elevated, bulbous subspherical body, the crest of which is as high or higher than the adjacent metacoxae; it is not hexagonal in shape with an emarginate posterior margin (*Canthoconidea*), nor bilaterally carinate with a median sulcus between the carinae (*Canthoconidea* and *Parealda*), nor rhomboidal and subimpressed (*Podisus*). Apparently this form is sufficiently distinct from other genera to have its own name. To that end the

name *Bulbostethus* is given to it to signify the presence of the spherical bulbous nature of the metasternum.

Bulbostethus, new genus

Size intermediate, about 9.0 mm. long; mildly depressed above, convex below, strongly so at the anterior region of the abdomen; subrhomboidal in shape. Head and anterior portion of the pronotum mildly declivous; body densely and rather regularly punctured above, with the exception of the head which is more finely and sparsely punctured.

Head two-thirds to three-quarters of the medial length of the pronotum; margins before the eyes very mildly sinuate, then subparallel; juga and tylus subequal, neither more prominent than the other; subtruncately rounded apically; ocelli prominent and about four times as far apart as each is from the eye. Antennae reaching a little beyond the middle of the scutellum, the terminal four segments essentially subequal. Bucculae very low, subparallel, and uniting posteriorly in line with the antennal tubercles. Rostrum only moderately stout, the apex reaching between the hind coxae, segment I not attaining the base of the head; segments II and III equal, IV three-quarters of the length of III.

Pronotum more than two and a half times as wide across the humeral apices as long medially; anterior margin more deeply excavated than in *Parealda*, then obliquely truncate behind the eyes; anterolateral margins sinuate before the humeri, then straight and there calloused-crenulate to the base of the humeri, ending anteriorly in an acute, forward projecting denticle which just exceeds the width of the head through the eyes; humeri elongate, either produced forward or transversely, certainly not retrorsely curved, the apices subacutely rounded; posterior angles subprominent, obtusely rounded; posterior margin straight. Scutellum almost as wide at the base as long medially, the frenum ending just behind the middle, the margins from there onward subparallel, the apex subtruncate, the external angles obtusely rounded, the extreme margins of the apex impunctate; basal angles deeply foveate. Hemelytra rather regularly punctured, hardly denser so on the embolium than on the corium; a darker, laevigate, discal spot present; apical margin of the corium straight, the external angle roundly acute, not reaching the base of the sixth connexival segment; membrane uniform pale brown, exceeding the abdominal apex by about one-third of its length and devoid of a longitudinal dusky vitta; veins numerous and subparallel. Connexivum narrowly exposed, the sixth segment flaring somewhat; apical segmental angles somewhat produced and becoming progressively more acute posteriorly, those on the sixth segment terminating in a minute acute denticle, but not prolonged into a spine.

Pleura prominently and regularly punctured, lateral portions of the abdomen more finely and obscurely so, the central portion of the disc glossy and impunctate. Mesosternum provided with a low, flat-topped carina, somewhat dilated at

each end. Metasternum mildly elevated into a small, subglobular nodule or bulla-like structure, the crest of which is as high as the metacoxae, and which is neither emarginate behind, nor carinate laterally. Median spine of the second abdominal sternite stout, conical at the base, slightly compressed anteriorly, the apex acute, feebly curved dorsally there and reaching between the mesocoxae. Central portion of the abdominal disc strongly elevated anteriorly, there continuous with the surface of the median spine, and then gradually decreasing in height posteriorly; the surface strongly convex there but with no median keel or carina evident. Male provided with a pair of small sericeous plagae on the fourth and fifth abdominal sternites. Legs moderate in length, the anterior femora devoid of anteapical spines or tubercles; tibiae essentially terete, dorsal surface slightly flattened apically, certainly not sulcate.

Genotype: *Bulbostethus chrysopterus* (Herrich-Schaffer).

The resemblance between examples of this genus and *Parealda*, *Canthoconidea* or other Micronesian asopines is strictly superficial, the likeness being emphasized because of approximate similarity in size, color and shape. Schouteden, however, has stressed the diagnostic importance of other morphological characteristics, such as the structure of the mesosternum, metasternum, abdomen and abdominal spines, among others. In this respect then, *Bulbostethus* is distinctive because it does not show similarity of these parts to other known genera. It belongs to that complex of asopines in which the second rostral segment is shorter than the following two combined; the terminal rostral segment is shorter than the preceding; the femora are aspinose and the tibiae terete; the anterior portion of the abdomen is well elevated and provided with a stout spine which reaches but does not surpass the mesocoxae; and the metasternum is neither flat nor bicarinate.

While the foregoing description may seem overly detailed and somewhat lengthy, it follows the format for such descriptions established by Schouteden in his monograph on the Asopinae in the Genera Insectorum. Some of the diagnostic characteristics given are probably of specific as much as generic magnitude, but are included for the sake of completeness.

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Insects and Other Arthropods from Midway Atoll

AMY SUEHIRO

BERNICE P. BISHOP MUSEUM
HONOLULU, HAWAII

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Midway Atoll lies 1150 nautical miles northwest of Oahu and consists of a nearly circular rim of coral reef about 5 miles in diameter enclosing a lagoon. Near the southern rim of the atoll are two low islets, Sand Island measuring about a mile and one-half long by a mile wide, and Eastern Island, triangular in shape and a mile and a quarter long by three quarters of a mile wide. Though Eastern Island always has had a growth of low shrub, Sand Island was originally covered with nearly bare sand. When a cable station was established on Sand Island in 1902, numerous plants, together with shiploads of soil were imported, principally from Hawaii. Undoubtedly many insects were introduced at the same time. From 1935 to 1950, Sand Island was an operating base for Pan American Airways, and it has been a refueling base for east-bound Armed Forces transport planes.

The first insect recorded from Midway was the moth, *Peridroma fasciata*, described in 1894 by W. Rothschild, and probably collected in July, 1891 by Henry Palmer, a bird collector for Rothschild. A few insects were taken by G. P. Wilder in 1905, but the first scientific survey of Midway was made by the Tanager Expedition in 1923, with D. T. Fullaway as entomologist, during the course of an exploration of islands of the Hawaiian chain northwest of Kauai. The entomological results were published by E. H. Bryan, Jr. and collaborators in B. P. BISHOP MUSEUM BULLETIN 31, 1926, which lists 43 species of insects in 12 orders from Midway.

During the past few years C. F. Clagg, with the U. S. Naval District Public Works, and Yoshio Oshiro, a construction worker with Hawaiian Dredging Company, have brought in numerous specimens from Midway. E. J. Ford, Jr. made an intensive survey of the atoll in November, 1959. Their collections form the basis for the present list, and bring the total number of insect species to approximately 205, to which are added one species each of scorpion, centipede, and mite, and 13 species of spiders.

For their assistance in determining specimens thanks are due to J. W. Beardsley, F. A. Bianchi, E. J. Ford, Jr., W. J. Gertsch, C. R. Joyce, D. E. Hardy, L. W. Quate, E. S. Ross, C. Sabrosky, R. L. Usinger, R. H. Van Zwaluwenburg, R. A. Ward, and C. M. Yoshimoto. The information about Midway Atoll is largely taken from AMERICAN POLYNESIA AND THE HAWAIIAN CHAIN by E. H.

Bryan, Jr. Species marked with an asterisk were previously recorded from Midway in BISHOP MUSEUM BULLETIN 31, unless otherwise noted.

ARACHNIDA

ACARINA

Tetranychiidae

Tetranychus ludeni Zacher, determined by E. W. Baker

ARANEIDA

Determined by W. J. Gertsch

Oonopidae

Oonops sp.

Sicariidae

Scytodes fusca Walckenaer

Scytodes longipes Lucas

Theridiidae

Achaearanea tepidarioria Koch

Theridion sp.

Argiopidae

Coloncus sp.

Neoscona vertebrata McCook

Clubionidae

Chiracanthium diversum Koch

Heteropoda venatoria Linnaeus

Salticidae

Hasarius adansoni Audouin

Menemerus bivittatus Dufour

Metaphidippus sp.

Sandalodes sp.

CHILOPODA

Scolopendridae

Scolopendra subspinipes Leach, immature

SCORPIONIDA

Buthidae

Isometrus maculatus DeGeer

INSECTA

THYSANURA

Lepismatidae

Ctenolepisma urbana Slabaugh

COLLEMBOLA

*Species not identified

ORTHOPTERA

Blattidae

Blatella germanica (Linnaeus)

Blatella lituricollis (Walker)
***Periplaneta americana** (Linnaeus)
Periplaneta australasiae (Fabricius)
***Pycnoscelus surinamensis** (Linnaeus)
Supella supellectilium (Serville)

Mantidae
Tenodera angustipennis Saussure (?); first instar nymphs

Acrididae
Atractomorpha sinensis Bolivar, determined by A. B. Gurney
Oxya chinensis (Thunberg)

Tettigoniidae
***Conocephalus saltator** (Saussure)
Elimaea punctifera (Walker)
Xiphidiopsis lita Hebard

Gryllidae
Gryllodes sigillatus (Walker)
Myrmecophila quadrispina Perkins

ISOPTERA

Rhinotermitidae
Coptotermes formosanus Shiraki

Kalotermitidae
***Cryptotermes brevis** (Walker). (Keck, PROC. HAW. ENT. SOC. 14:351, 1952)

EMBIOPTERA

Oligotomidae
Oligotoma saundersii (Westwood), determined by A. B. Gurney

DERMAPTERA

Labiduridae
Anisolabis eteronoma Borelli
Anisolabis perkinsi Burr
***Euborellia annulipes** (Lucas)
Labidura riparia (Pallas), determined by A. B. Gurney

CORRODENTIA

Peripsocidae
Ectopsocus perkinsi Banks, determined by E. L. Mockford
*Psocids, unidentified

MALLOPHAGA
Determined by R. A. Ward

Philopteridae
Docophoroides sp., probably new
Halipeurus sp., nymph; host probably *Pterodroma* or *Puffinus*
Trabeculus sp., 1 female; host probably *Pterodroma* or *Puffinus*

Menoponidae
Austromenopon sp. host probably *Pterodroma* or *Puffinus*

THYSANOPTERA

Thripidae

Frankliniella minuta (Moulton), on *Verbesina encelioides*, determined by F. A. Bianchi

***Chirothrips mexicanus** Crawford, on sedges. (Bianchi, PROC. HAW. ENT. SOC. 11(1):37, 1941).

***Thrips hawaiiensis** (Morgan), on alfalfa and *Leucaena glauca*. (*ibid*)

***Thrips tabaci** Lindeman, on onions and cultivated flowers. (*ibid*)

Phlaeothripidae

***Haplothrips gowdeyi** Franklin, on *Eragrostis variabilis*. (*ibid*)

Heliothrips haemorrhoidalis (Bouché), determined by K. O'Neal.

HOMOPTERA

Cicadellidae

Balclutha timberlakei (Osborn), determined by R. Namba

Delphacidae

***Liburnia paludum** (Kirkaldy)

Membracidae

Spissistilus festinus (Say)

Vanduzea segmentata (Fowler)

Aleyrodidae

Specimen in poor condition.

Aphidae

***Aphis gossypii** Glover, on marigolds (Bianchi, PROC. HAW. ENT. SOC. 11 (1):37, 1941.)

***Aphis medicaginis** Koch. on alfalfa

Margarodidae

Icerya purchasi Maskell on *Casuarina*

Pseudococcidae

Phenacoccus gossypii (Townsend & Cockerell)

Planococcus citri (Risso), determined by J. W. Beardsley

Palmicola palmarum (Ehrhorn), determined by J. W. Beardsley

Coccidae

Coccus acuminatus (Signoret)

Coccus viridis (Green), determined by Beardsley

Saissetia nigra (Nietner), determined by Beardsley

Diaspididae

Chrysomphalus ficus (Ashmead) on coconut, determined by Beardsley

Pinnaspis strachani (Cooley), determined by Beardsley

HETEROPTERA

Cynidae

Geotomus pygmaeus (Dallas)

Coreidae

Liorhyssus hyalinus (Fabricius)

Lygaeidae (Determined by R. L. Usinger)
*Nysius fullawayi fullawayi Usinger (B. P. BISHOP MUSEUM BULL. 173:93, 1942.)
Nysius kinbergi Usinger
Nysius plebeius Distant (?)
Nysius terrestris Usinger
Reduviidae
Empicoris rubromaculatus (Blackburn)
Empicoris sp. probably whitei (Blackburn), determined by Ford
Zelus renardii Kolenati
Nabidae
*Nabis capsiformis Germar
Anthocoridae
*Orius persequens (White)

NEUROPTERA

Chrysopidae
*Chrysopa lanata Banks (Zimmerman, INSECTS OF HAWAII 6:90, 1957.)
Hemerobiidae
Sympherobius barberi (Banks)

LEPIDOPTERA

Tineidae
Ereunetis simulans (Butler)
Opogona aurisquamosa (Butler)
Hyponomeutidae
*Plutella maculipennis Curtis
Gracilariidae
*Petrochroa dimorpha Busck
Cosmopterygidae
Pyroderces rileyi (Walsingham), determined by Ford
Gelechiidae
Stoeberhinus testaceus Butler
Oethrutidae
Bactra sp., determined by J. F. G. Clark
Tortricidae
Amorbia emigratella Busck
Pterophoridae
Lioptilodes parvus (Walsingham) ? Rubbed specimen
*Megalorhipida defectalis (Walker) (Recorded as Trichoptilus oxydactylus (Walker))
Pyralidae
Hymenia recurvalis (Fabricius)
Hellula undalis (Fabricius)
Pyralis manihotalis Guenée

Noctuidae

Achaea janata (Linnaeus) (A single capture; may not be established)

***Agrotis** (Peridroma) **fasciata** (Rothschild) (Not seen; specimens in British Museum)

***Plusia chalcites** (Esper)

***Prodenia** sp. ? (Not seen; probably a misidentification)

Pseudaletia unipuncta (Haworth), determined by C. W. Capps

Spodoptera mauritia acronyctoides (Guenée), determined by Ford

COLEOPTERA

Staphylinidae

Philonthus spp. determined by Ford

***Staphylinid,** undetermined

Cleridae

Necrobia rufipes DeGeer

Oedemeridae

Ananca bicolor (Fairmaire)

Ananca decolor (Fairmaire)

Elateridae (Determined by R. H. Van Zwaluwenburg)

***Conoderus exul** (Sharp)

Conoderus pallipes (Eschscholtz)

Conoderus sp. not determined

Dermestidae

Attagenus gloriosae Fabricius

***Dermestes ater** (DeGeer) (Recorded as *D. cadaverinus* Fabricius)

Dermestes maculatus (DeGeer)

Eucnocerus anthrenoides Sharp

Histeridae

Saprinus lugens Erichson

Mycetophagidae

Typhaea stercorea (Linnaeus)

Colydiidae

Euxestus parki Wollaston

Lyctidae

Lyctus brunneus Stephens

Nitidulidae

Carpophilus dimidiatus (Fabricius), determined by Ford

Bostrychidae

Heterobostrychus aequalis Waterhouse, in rattan furniture from Honolulu, determined by Ford.

Coccinellidae

Coelophora inaequalis (Fabricius)

Olla abdominalis (Say)

Platyomus lividigaster Mulsant
Rodolia cardinalis (Mulsant)
Rhizobius ventralis Erichson, determined by E. A. Chapin
Scymnus notescens (Blackburn)

Tenebrionidae
Blapstinus dilatatus Leconte
Gonocephalum adpressiforme Kaszab, determined by T. J. Spilman
Platydema subfascia Walker, determined by Ford
Tribolium castaneum (Herbst), determined by Ford

Cerambycidae
Ceresium unicolor (Fabricius)
Sybra alternans Wiedemann

Chrysomelidae
Diachus auratus (Fabricius)

Bruchidae
Mimosestes sallaei (Sharp), determined by Ford
Stator pruininus (Horn)

Curculionidae
Dryophthorus distinguendus Perkins, determined by Ford
***Dryotribus wilderi** Perkins
***Oodemas laysanensis** Fullaway
Oxydema fusiforme (Wollaston), determined by Ford
Oxydema longulus (Boheman), determined by Ford
Pantomorus godmani Crotch
***Pentarthrum halodorum** Perkins

Scolytidae
Hypothenemus sp. ? in dead Hibiscus sp., determined by Ford

Anthribidae
Araecerus levipennis Jordan
Exillis lepidus Jordan

Scarabaeidae
Adoretus sinicus Burmeister
***Anomala sulcatula** Burmeister (Van Zwaluwenburg, PROC. HAW. ENT. SOC. 16(1):2, 1956)

DIPTERA

Psychodidae
Psychoda williamsi Quate, determined by L. W. Quate

Culicidae
Aedes albopictus Skuse
***Culex quinquefasciatus** Say (Hu, PROC. HAW. ENT. SOC. 14(3):351, 1952)

Ceratopogonidae (Determined by D. E. Hardy)
Dasyhelea calvescens Macfie

Cecidomyiidae (Determined by Hardy)
Giardomyia pallidithorax Hardy
Parallelodiplosis bimaculata Hardy
Sciaridae
Sciara (Lycoriella) garretti Shaw, determined by Hardy
***Sciara (Lycoriella) molokaiensis** Grimshaw (Probably a misidentification—Hardy)
Dolichopodidae
Condylostylus sp., determined by R. H. Foote
***Chrysosoma fraternum** Van Duzee (recorded as *Psilopus patellifer* Thomson)
Chrysotus pallidipalpus Van Duzee, determined by Hardy
Medetera atrata Van Duzee
Syrphidae
Xanthogramma scutellaris Fabricius
Calliphoridae
Chrysomyia megacephala Fabricius
Dyscritomyia sp., teneral
***Lucilia graphita** Shannon
***Ophyra chalcogaster** Wiedemann, determined by C. R. Joyce
Phaenicia sericata (Meigen)
Rhinia testacea (Robineau-Desvoidy), determined by C. R. Joyce
Sarcophagidae
***Goniophyto bryani** Lopes (Lopes, B. P. BISHOP MUS., OCC. PAPERS 14(11): 195, 1938)
Helicobia morionella (Aldrich), determined by Joyce
Parasarcophaga argyrostoma (Robineau-Desvoidy)
Parasarcophaga misera (Walker), determined by Joyce
Muscidae
Fannia pusio (Wiedemann)
Fucellia sp., determined by R. Foote
Musca domestica Linnaeus (Also reported as *M. vicina* Macquart)
Muscina assimilis (Fallen), determined by Joyce
Ophyra aenescens (Wiedemann), determined by Hardy
Ophyra sp.
Chyromyidae
Chyromyia sp., in poor condition, determined by C. Sabrosky
Lauxaniidae
Homoneura unguiculata (Kertesz)
Drosophilidae
Drosophila simulans Sturtevant, determined by Hardy
Chloropidae
***Cadrema pallida** Loew (Misidentified as *Hippelates nigricornis flavus* Thomson —Hardy)

Siphunculina signata Wollaston, determined by Hardy
Agromyzidae
Liriomyza sp., in poor condition, determined by Hardy
Phytobia sp., determined by Hardy
Phytoliriomyza sp., determined by Hardy
Ephydridae
Hecamede persimilis Hendel, determined by Hardy
Tethinidae
Tethina albula (Loew)
Tethina insularis Aldrich, determined by Hardy
Milichiidae
Desmometopa tarsalis Loew, determined by Hardy
Desmometopa sp., determined by Hardy
***Milichiella lacteipennis** (Loew)
Canaceidae
Nocticanace sp., determined by W. W. Wirth
Sphaeroceridae
***Limosina** sp., near **ferruginata** (Stenhammer) (reported as *Leptocera* sp.)

HYMENOPTERA

Evaniidae
Evania appendigaster (Linnaeus)
Braconidae
Apanteles carpatus (Say), determined by C. F. W. Muesebeck
***Chelonus blackburni** Cameron
Phanerotoma hawaiiensis Ashmead, determined by C. M. Yoshimoto
Urosigalphus bruchi Crawford, determined by Muesebeck
Ichneumonidae
Diplazon laetatorius Fabricicius
Idechthis canescens (Gravenhorst), determined by Yoshimoto
Idechthis sp. near **canescens**
Chalcididae
Antrocephalus pertorvus (Girault), determined by Muesebeck
Encyrtidae
***Anagyrus swezeyi** Timberlake
***Pauridia peregrina** Timberlake
Pteromalidae
Lariophagus texanus Crawford, determined by B. D. Burks
Eulophidae
***Elachertus advena** Timberlake
Tetrastichus sp., determined by K. V. Krombein
Formicidae
Camponotus variegatus hawaiiensis Forel, determined by Ford

***Cardiocondyla nuda minutior** Forel
***Monomorium minutum** Mayr
***Nylanderia bourbonica hawaiiensis** (Forel)
Paratrechina longicornis (Latreille), determined by Hardy
***Pheidole megacephala** Linnaeus
Plagiolepis alluaudi Emery, determined by R. M. Smith
Solenopsis geminata Fabricius
***Tapinoma melanocephalum** (Fabricius)
***Tetramorium guineense** (Fabricius)

Bethylidae
Epyris sp., determined by Krombein

Mymaridae
***Polynema reduvioli** Perkins

Vespidae
Icaria marginata (Lepeletier)
Pachodynerus nasidens Saussure
Polistes aurifer Saussure

Ampulicidae
Ampulex compressa (Fabricius)
Dolichurus stantoni Ashmead

Sphecidae
Chlorion (Sphex) harrisi (Fernald)
Sceliphron caementarium (Drury)

Megachilidae
Megachile (Eumegachile) umbripennis Smith

Apidae
Xylocopa varipuncta Patton

The Abundance of the Hawaiian Trees and the Number of Their Associated Insect Species

T. R. E. SOUTHWOOD

DEPT. OF ZOOLOGY & APPLIED ENTOMOLOGY,
IMPERIAL COLLEGE,
LONDON, ENGLAND

(*Submitted for publication January, 1960*)

In a recent paper on the number of insect species associated with British trees (Southwood, 1960), the author suggested that the reason why some trees had more associated insect species than others was not entirely a matter of the biochemistry of the plant, but to a large extent a reflection of the abundance of the tree in recent geological history. When allowance is made for this effect of the host-tree's abundance on the number of insect species, then certain trees can be shown to have more or fewer insect species than might be expected from a consideration of abundance alone. It is these trees whose structural and biochemical properties are probably peculiar in some way and therefore would warrant a further investigation.

The British flora and fauna are largely just a sample of that of the Palaearctic region, and although Southwood (1960) was able to show in a comparison of Britain with Cyprus and Russia that the number of associated insect species showed a direct correlation with the abundance patterns of the trees in each country, it is not clear whether this relationship (of abundance with insect species) is due mainly to an evolutionary process or to the chances of an immigrant species finding its correct host plant or both. A large number of both the tree and insect species of Hawaii are endemic and, therefore, if a similar relationship could be shown to exist in these islands, this would indicate that such relationship is evolutionary and not just a dispersal effect, confined to an area (e.g. Britain) on the periphery of a faunal and floral region.

Swezey (1954) has provided a comprehensive list of the insect species associated with various trees and plants in the Hawaiian forest. This is based on over 40 years collecting by Dr. Swezey and on observations by other workers. He points out that future studies will add to the list, but it seems unlikely that these omissions of undescribed species are biased in the direction of any particular abundance group of trees. It might be suggested that a more serious source of bias would be the difficulty of making many collections from the rarer trees. Against this should be set the tendency to collect from a rare tree whenever encountered.

The total number of insect species attached to each tree and the number of species specific to it have been taken from Swezey (1954) and are given in table 1.

A measure of the relative abundance of the different Hawaiian trees—before the large scale disturbance by man in this century—has been taken from the descriptions by Rock (1913) and in doubtful cases checked against Hillebrand (1888). Four groups are recognised: the first contains those species described as "local" or "rare", sometimes occurring in only one locality; the second those said to be "not uncommon" or "rather common" in many areas or "common" in a few more restricted localities; the third, widespread species which are "common" or "most common"; and the fourth two trees only, *Acacia koa* and *Metro-*

TABLE 1. Hawaiian trees grouped according to abundance (pre 20th century) with the numbers of associated insect species (based on Swezey, 1954). (x = significant at 5% level, xx = significant at 1% level, xxx = significant at 0.1% level).

TREE	NUMBER OF ASSOCIATED INSECT SPECIES		
	UNIQUE ON THIS TREE ONLY	OTHERS	TOTAL
GROUP 1 "LOCAL" and "RARE"			
Claoxylon sandwicense	0	7	7
Drypetes phyllanthoides	1	5	6
Mezoneurum kauaiense	1	3	4
Pteralyxia macrocarpa	1	7	8
Pterotropia kauaiensis	5	5	10
Rauwolfia sandwicensis	1	0	1
Reynoldsia sandwicensis	1	0	1
Xylosoma hawaiiensis	4	4	8
Mean	1.8	3.9	5.6
"t" for comparison with mean of group 2	1.94	1.81	3.45 xx
GROUP 2 "NOT UNCOMMON" and "RATHER COMMON"			
Acacia koaia	0	24	24
Alphitonia excelsa	0	12	12
Antidesma platyphyllum	5	11	16
Bobea elatior	7	14	21
Charpentiera spp.	5	8	13
Dracaena aurea	4	9	13
Erythrina sandwicensis	1	10	11
Myoporum sandwicense	6	19	25
Nothocestrum spp.	2	0	2
Pandanus odoratissimus	6	16	22
Plectronia odorata	2	3	5
Pritchardia spp.	10	12	22
Sapindus spp.	0	4	4
Syzygium sandwicense	4	13	17
Tetraplasandra spp.	5	15	20
Wilkstroemia	7	21	28
Zanthoxylum spp.	2	11	13
Mean	3.9	11.9	15.8
"t" for comparison with mean of group 3	2.99 xx	2.84 xx	3.56 xxx

TABLE 1—(Continued)

TREE	NUMBER OF ASSOCIATED INSECT SPECIES		
	UNIQUE ON THIS TREE ONLY	OTHERS	TOTAL
GROUP 3 "COMMON" and "WIDELY DISTRIBUTED"			
Aleurites moluccana	1	16	17
Broussaisia arguta	10	16	26
Cheirodendron spp.	9	12	21
Coprosoma spp.	13	47	60
Dodonaea viscosa	7	14	21
Dubautia spp.	14	31	45
Elaeocarpus bifidus	5	23	28
Euphorbia spp.	25	9	36
Gouldia spp.	9	35	44
Hibiscus spp.	8	20	28
Ilex anomala	1	10	11
Maba spp.	4	12	16
Myrsine spp.	15	26	41
Osmanthus sandwicensis	3	12	15
Pelea spp.	27	10	37
Perrottetia spp.	3	15	18
Pipturus spp.	39	75	114
Pisonia umbellifera	7	20	27
Scaevola spp.	4	36	40
Sophora chrysophylla	13	31	44
Straussia spp.	14	29	43
Styphelia tameiameia	10	22	32
Urera sandwicensis	6	9	15
Mean	10.7	23.0	33.9
"t" for comparison with mean of group 4	2.11 x	3.00 xx	4.15 xxx
GROUP 4 "VERY ABUNDANT"			
Acacia koa	41	110	151
Metrosideros polymorpha	40	56	96
Mean	40.5	83.0	123.5

sideros collina polymorpha, which appear to have been the dominants on the islands. When there is a large genus of allied trees (e.g. *Myrsine*) or a few tree species allied to numerous herbaceous ones (e.g. *Euphorbia*) these are placed in a higher abundance group than that appropriate for the individual species. This is because to insects that attack all members of the genus they are relatively more abundant. Evidence in support of this may be found in the comparatively large numbers of non-specific insects associated with *Acacia koaia*, a tree that might almost be placed in group 1 and yet is closely allied to the dominant *A. koa*. It is also noteworthy in relation to the main hypothesis that apparently no insects specific to *A. koaia* have evolved.

The results of placing the trees in the abundance groups, and the mean value of specific or unique, "other", and total associated insects for each group will be seen in table 1. It is clear that the more abundant trees have more associated

insects, thus supporting Southwood's (1960) hypothesis. Successive means have been compared by the "t" test and the values for "t" are given in table 1. In the majority of cases these are significant.

As this relationship seems so strong in Hawaii, it is apparent that an important factor in the correlation between the number of associated insect species and tree abundance is evolutionary. What mechanism can we envisage?

The number of insect species that develop resistance to an insecticide is largely determined by the frequency with which different individuals of the insect species are exposed to it. An insecticide that is widely and repeatedly used will have more resistant species than one used locally and irregularly. It is suggested that the evolution of the ability to feed on various trees, which, for example, may involve the production of a mechanism to render non-toxic certain alkaloids or glucosides, or to accept some new chemical as a phagostimulant, is analagous to, although far more complex and slower than the evolution of resistance to insecticides. Insects arriving on the host plant and unable to feed on it must often perish; thus, the number of times individuals of an insect species were exposed to a particular tree would determine whether the tree became a host plant. The number of such encounters would depend on the abundance of the tree and also (although this is not relevant here) on the abundance and the reproductive and dispersal rates of the insect.

Further evidence in support of this view is provided by the observation that when a tree is imported into a new country and grown extensively (e.g. cacao in West Africa) sooner or later several native insects come to feed on it; whereas an introduced tree, without closely allied species in the native flora, that remains relatively rare (e.g. ornamental shrubs such as *Spirea* & *Forsythia* in England) will have few, if any, native insects feeding on it. Furthermore, when a tree becomes more abundant as a result of cultivation, an increasing number of insect species often appear to feed on it. Sometimes this is partly due to transfers from other host plants, as with the mirids *Plesiocoris rugicollis* (Fallen) and *Orthotylus marginalis* Reuter on apple in Britain. In other cases a second type of mechanism seems to come into play in which the increase is due to the invasion of the area by insect species already attached to the host tree in other countries (e.g. with Scot's pine (*Pinus sylvestris*) in southern England since 1930 (Southwood, 1957)). The chances of success of such invasions, especially if we envisage them due to aerial dispersal, will depend on the abundance of the host tree.

It may be objected that the abundance patterns of the trees was largely determined during the Quaternary, but that most insect species had evolved long before this period. This is true, but feeding habits may change quite quickly. For example, the mirids on apple referred to above, the birch feeding Lygaeid, *Kleidocerys resedae* (Panzer), which is now found on *Rhododendron* in southern England, and the two mirids (*Sahlbergella singularis* Hage and *Distantiella theobroma* Distant) on cacao in West Africa (Cotterell, 1930) all appear to have become associated with these new host plants during this century. The cacao

mirids have fed on cacao trees of all ages only in the last fifteen years (Taylor, 1954).

In conclusion, therefore, it is suggested that the relationship between the abundance of a tree and the number of insect species associated with it is primarily an effect of abundance, which determines the number of encounters between an insect species and the tree, thereby influencing the rate of evolution of the ability to feed on that tree. This relationship is further strengthened by the process whereby, when a tree colonises an area outside of its main evolutionary center, its abundance determines the probability of its being found by immigrant individuals of insect species which feed upon it in its original home.

ACKNOWLEDGEMENTS

I am grateful to Dr. R. L. Usinger and the members of the Editorial Board of the Hawaiian Entomological Society for criticising this paper in manuscript; any errors of fact or interpretation are, of course, the author's.

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A Nuclear Polyhedrosis Virus of the Lawn Armyworm, Spodoptera mauritia (Boisduval) (Lepidoptera: Noctuidae)[1]

YOSHINORI TANADA

LABORATORY OF INSECT PATHOLOGY
DEPARTMENT OF BIOLOGICAL CONTROL
UNIVERSITY OF CALIFORNIA, BERKELEY

(*Submitted for publication July, 1959*)

Slightly over two years after the lawn armyworm, *Spodoptera mauritia* (Boisduval), was first recorded in Hawaii, a nuclear polyhedrosis of this insect was discovered by Bianchi (1957). This virus disease plays an important role in the natural control of the lawn armyworm (Tanada and Beardsley, 1958). According to Tanada and Beardsley (1957), the nuclear polyhedrosis virus may have entered Hawaii together with its host. However, no reference has been found by the author to any polyhedrosis disease of the lawn armyworn outside of Hawaii. A disease of this armyworm in South India was considered by Anantanarayanan and Ramakrishna Ayyar (1937) as probably of bacterial origin, but the symptoms recorded by them resemble somewhat those of the nuclear polyhedrosis described in the present report. The descriptions and characteristics of the virus and the disease in the lawn armyworm are presented below.

The study of the pathogenesis of the nuclear polyhedrosis was conducted with larvae reared individually in sterilized, half-pint cardboard containers that were covered with a half of a sterilized petri dish. These larvae were fed mainly tender young shoots of napier grass, *Pennisetum purpureum* Schumach. The temperature in the laboratory ranged in general between 72° F. (22° C.) and 85° F. (29° C.) with occasional extremes of 68° F. (20° C.) and 86° F. (30° C.). The relative humidity was ordinarily 56 to 85 per cent, with extremes of 50 and 92 per cent.

For the histopathological study, the larvae were fixed in alcoholic Bouin's solution (Duboscq-Brasil's modification) and prepared for sectioning through a methyl benzoate and benzene series and thence into paraffin (see Romeis,

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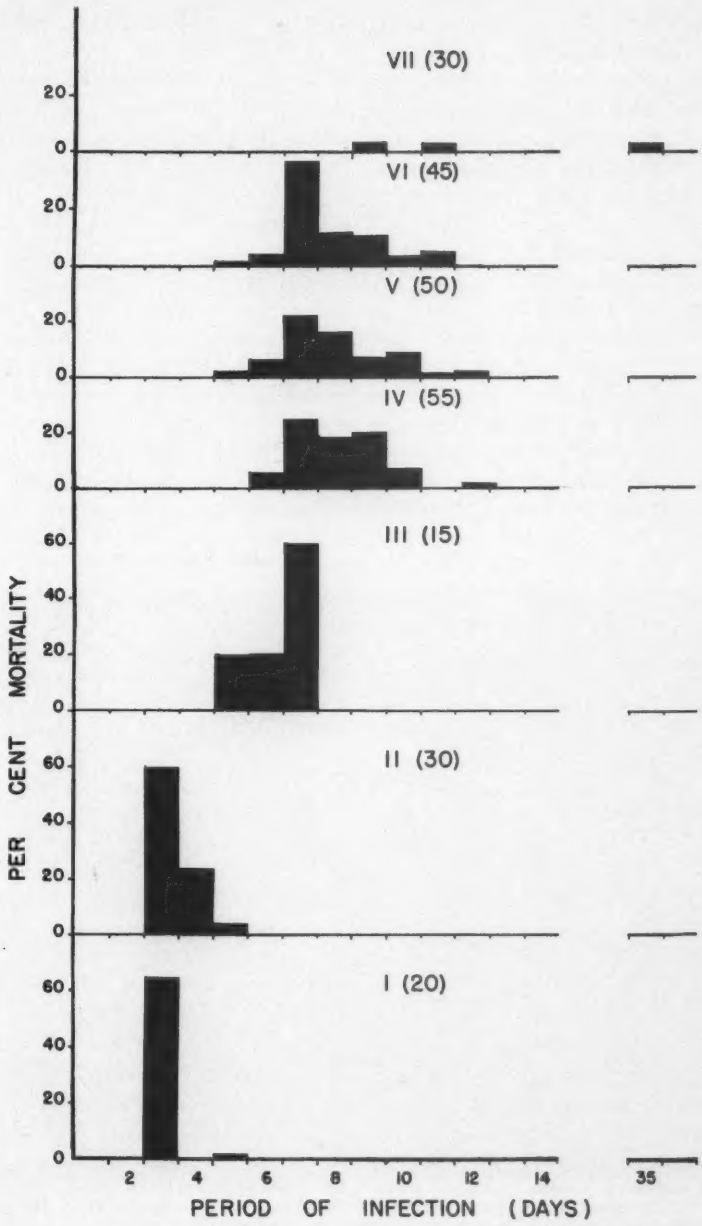
[1] Portions of the study were conducted at the Department of Entomology, University of Hawaii Agricultural Experiment Station, and the study is presented with the approval of the Director as Technical Paper No. 452.

FIG. 1. The period of lethal infection of nuclear polyhedrosis virus in the larvae of *Spodoptera mauritia* as affected by the time of inoculation in the different instars. Roman numerals indicate larval instars, and Arabic numerals in parentheses the total number of larvae tested in each instar.


VII (30)
VI (45)
V (50)
IV (55)
III (15)
II (30)
I (20)
PER CENT MORTALITY
PERIOD OF INFECTION (DAYS)
2
4
6
8
10
12
14
35

1948). The larvae were sectioned longitudinally at 8 μ and stained with Heidenhain's iron-hematoxylin and eosin.

The polyhedra were purified by repeated centrifugations and washings with distilled water. The virus particles were obtained by dissolving the ployhedra with 0.1 M. Na_2CO_3 and purified by several centrifugations and washings with distilled water. For the electron microscope study, a drop of the polyhedra or virus suspension was dried on the electron microscope grid, shadowed with palladium, and then observed with a RCA electron microscope, type EMU-2B.

The larvae shortly after succumbing to the virus show the typical symptoms of nuclear polyhedrosis, (*i.e.*, their skins become fragile and their internal contents a fluid mass, a typical "wilt" condition). Larvae which become infected in their early instars and die before the fourth instar usually begin to turn pale 2 to 4 days prior to death and, at death, have a whitish or creamy appearance. After death the larvae rapidly darken in color. Older infected larvae which die in the fifth or older instars gradually turn slightly pale with a pinkish tinge several days before death, but otherwise remain nearly as dark brown as the healthy larvae. Thus, in older larvae, change in coloration is not as marked as in the younger larvae.

For the determination of the period of lethal infection (*i.e.*, the period from exposure to the virus until death) massive doses of suspensions of polyhedra on grass leaves were fed to the larvae. The period of lethal infection varied with the larval instars (fig. 1). When infected in the first instar most of the larvae died in 3 days; when in the second instar most of them died in 3 to 4 days; when in the third instar they died in 5 to 7 days; in the fourth to sixth instars most died in 7 to 10 days; when in the seventh instar the larvae were fairly resistant to infection, and the few that were infected died in 9 days or longer. In general, the first 6 larval instars were highly susceptible to the virus, but the last instar seemed to be fairly resistant (only 3 out of 30 larvae were infected in two separate tests).

In infected mature larvae the histopathology is generally similar to that of most nuclear polyhedroses in other insects. The main sites of infection are the hypodermis, fat body and tracheal matrix. Occasionally the nuclei of the striated muscle and of the cells surrounding the nerve cord are infected. At times a few cells in other tissues and organs, such as the ganglia, brain, blood, the secretory portion of the salivary gland, the epithelia of the fore-and hindguts, and the cellular sheath around the testes may contain polyhedra within their nuclei. Nuclei of a few midgut cells located near the junction of the mid- and hindguts were also observed to be infected in one specimen.

The diameter of 50 polyhedra that were measured varied from about 1.07 μ to 3.22 μ with a mean of 1.61 μ, the standard error of which was $\pm$ 0.07 μ (fig. 2A). Widths of 30 naked virus rods ranged from 56.7 mμ to 66.2 mμ, with a mean

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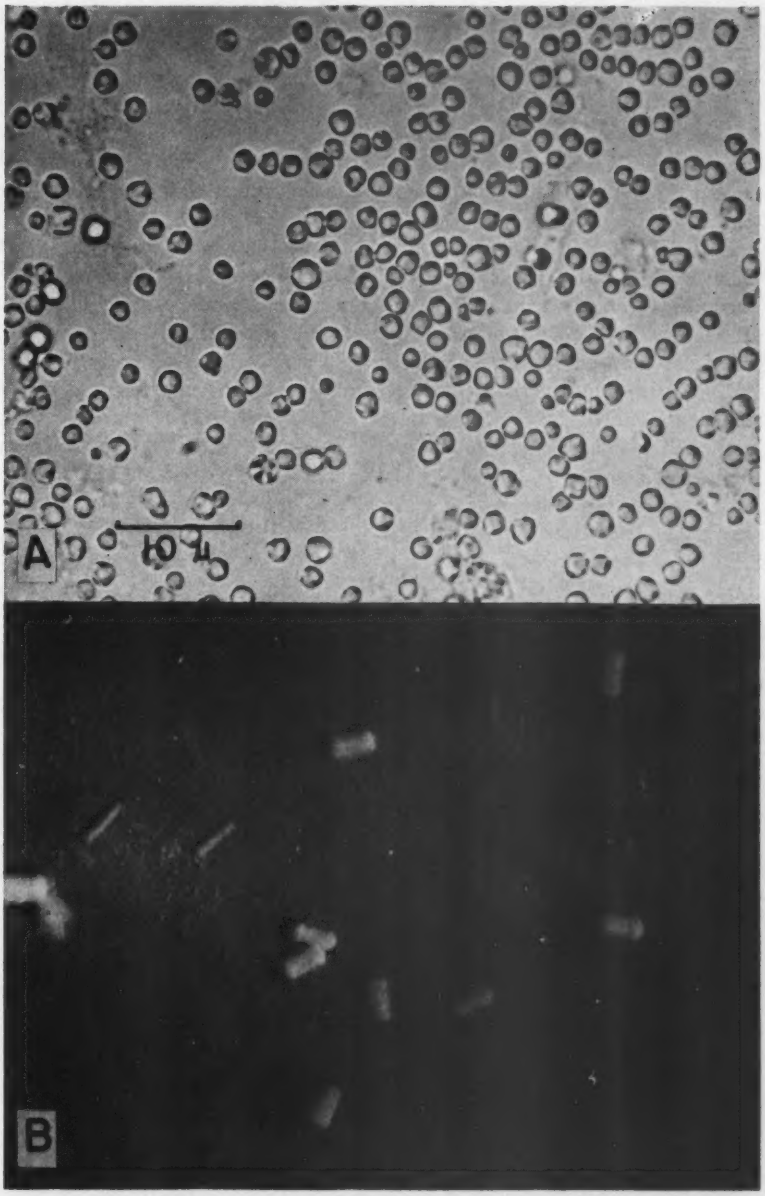
FIG. 2. Nuclear polyhedrosis virus of the lawn armyworm, *Spodoptera mauritia*. A, Polyhedra suspended in water. Photograph taken under an oil immersion planachromat objective (n.a. 1.25) of a Carl Zeiss photomicroscope with built-in automatic timing device. B, Electron micrograph of free virus rods showing individual rods and bundles of rods.


A
10 μ
B

of 61.9 mμ and a standard error of ± 0.59 mμ; their lengths varied from 298.1 mμ to 364.3 mμ with a mean of 324.7 ± 3.37 mμ (fig. 2B).

Cross infectivity tests were conducted with the nuclear polyhedrosis virus of *Spodoptera mauritia* and with the nuclear polyhedrosis and granulosis viruses of the cosmopolitan armyworm, *Pseudaletia unipuncta* (Haworth). In the first test the polyhedra of *S. mauritia* were fed to 25 second-instar larvae of *P. unipuncta*, and an equal number of untreated larvae were maintained as controls. None of the larvae died from virus infection. In the second test the polyhedra of *S. mauritia* were fed alone and in combination with the capsules (granulosis virus) of *P. unipuncta* to fourth-instar larvae of *P. unipuncta*. None of the treated or control larvae died with polyhedra within them. On the other hand, 10 control larvae of *P. unipuncta* fed a mixture of polyhedra and capsules both from *P. unipuncta* died of nuclear polyhedrosis. Each treated group contained 15 larvae.

Two tests on the infectivity of the nuclear polyhedrosis and granulosis viruses of *P. unipuncta* were conducted with the lawn armyworm. The viruses were fed alone and combined together. Third-instar larvae were used in both tests. In the first test all groups contained 15 larvae, and in the second all contained 12 larvae, except the control which contained 10. None of the treated or control larvae died from either virus disease.

Inasmuch as the virus is rod-shaped and occurs within a polyhedral inclusion body which develops in the nucleus of the host cell, it belongs to the genus *Borrelinavirus* (see Bergold 1958).

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New Immigrant Records for the Year 1959

Species marked with an asterisk were reported from the Hawaiian Islands for the first time during 1959 on the dates recorded in the text. Those marked with a dagger are considered doubtfully established as those records are based on single specimens. The species marked with a double dagger was formerly considered doubtfully established, but its establishment here has now been confirmed. Those not so marked were reported previously under incorrect or incomplete determinations. New species considered to be endemic to the Hawaiian Islands are not included in this list.

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Correspondence concerning the "PROCEEDINGS" should be addressed to the Secretary, Hawaiian Entomological Society, 1527 Keeaumoku St., Honolulu 14, Hawaii, U. S. A.